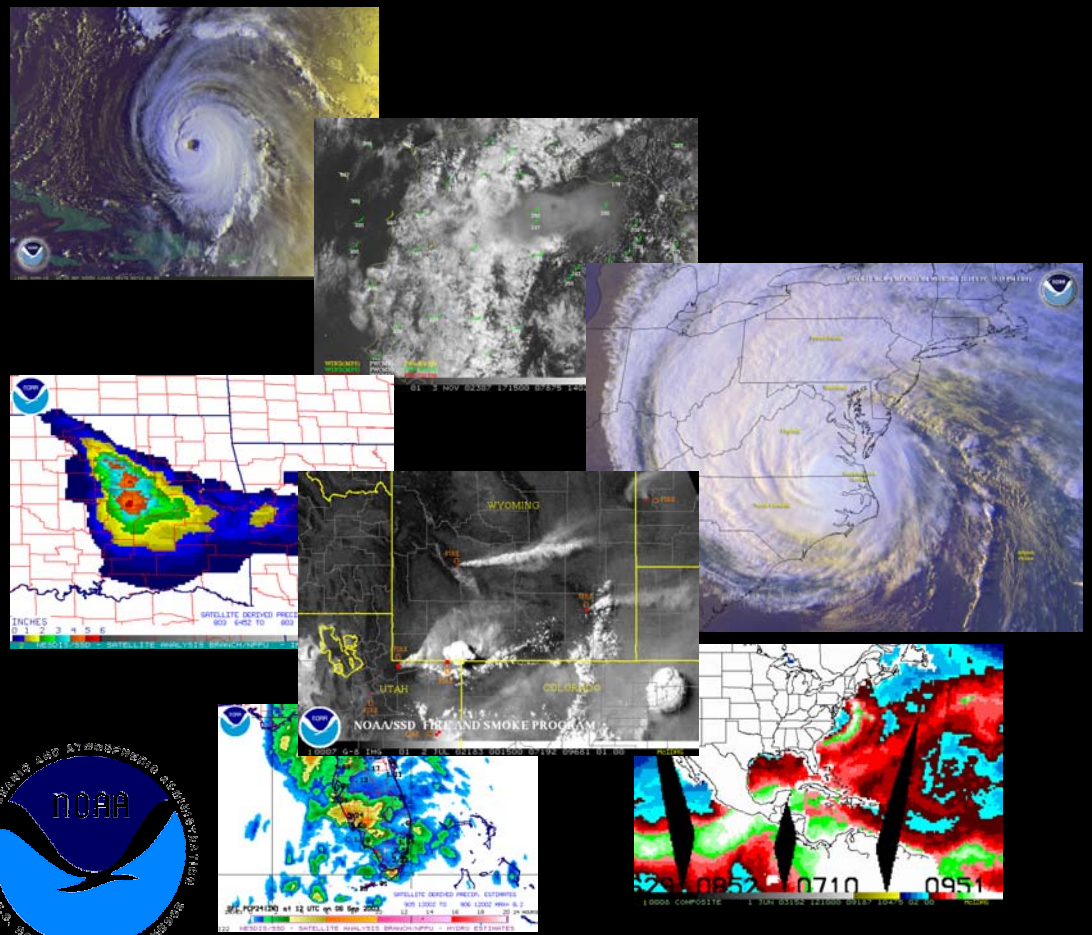
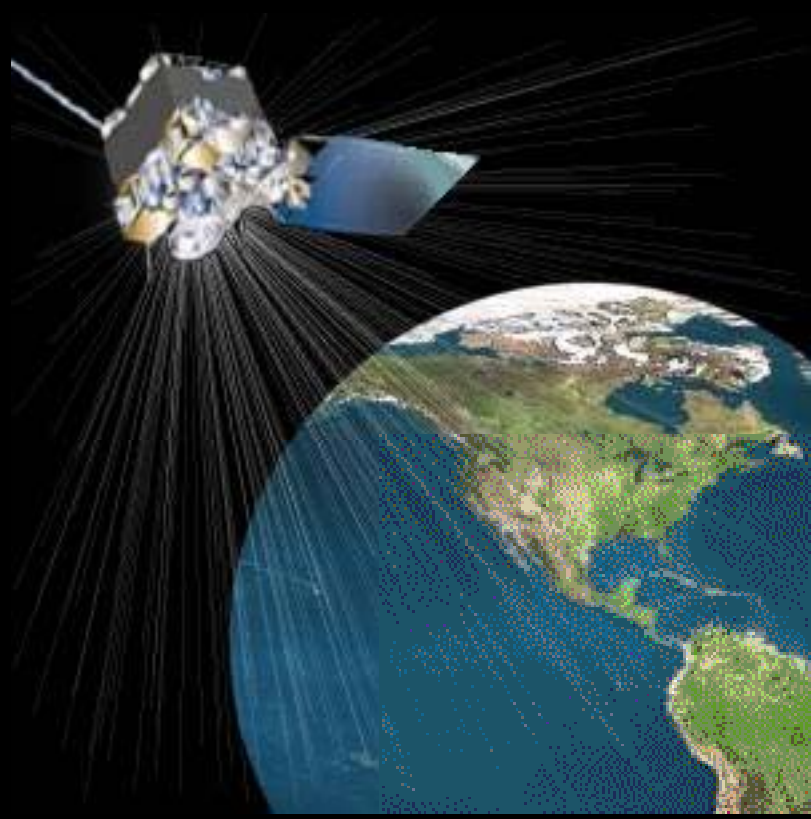
Satellite Products and Services of the NOAA/NESDIS Satellite Services Division for the Support of Near Real-Time Environmental Applications





Office of Satellite Data Processing and Distribution

Suitland, Maryland

Information Processing Division (IPD)
- Product Systems Branch
- Computer Operations Branch
- Satellite Active Archive (SAA)

Direct Services Division (DSD)
- Direct Satellite Readout
- Search and Rescue Satellite Aided Tracking
- GOES Data Collection
- ARGOS Data Collection

Satellite Services Division (SSD)
- Interactive Processing Branch
- Satellite Analysis Branch

Satellite Services Division

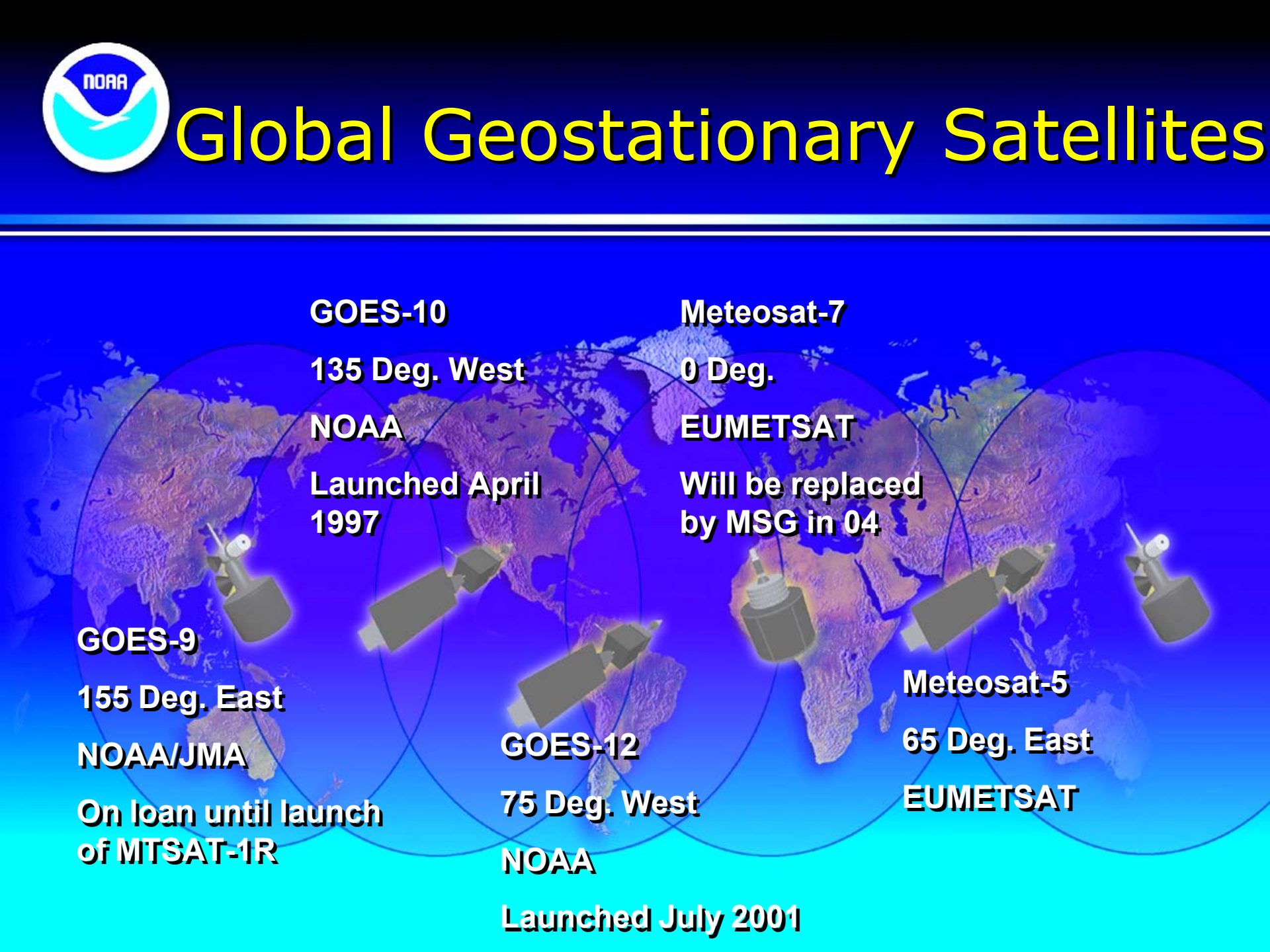
Mission Statement

"The Satellite Services Division supports the National Oceanic and Atmospheric Administration and the National Environmental Satellite, Data, and Information Services mission by providing real-time and near real-time environmental data, analyses, and interpretations from polar-orbiting and geostationary operational environmental satellites to a diverse user community for environmental assessment, prediction, and stewardship."

Satellite Services Division

The Satellite Services Division, part of the Office of Satellite Data, Processing, and Distribution, serves as the primary interface with a large user community of environmental satellite data and products. The division develops and maintains an operational ***real time*** satellite data distribution network, with customers all over the globe from various government agencies to private industry to educational institutions. Remapped GOES imagery is delivered to NOAAPORT, which in turn delivers satellite imagery for use in NWS Weather Forecast Offices. Using the latest technology and state of the art equipment and hardware, the division can routinely ingest and serve terabytes of data per day.

Global Geostationary Satellites



GOES-10

135 Deg. West

NOAA

Launched April 1997

Meteosat-7

0 Deg.

EUMETSAT

Will be replaced by MSG in 04

GOES-9

155 Deg. East

NOAA/JMA

On loan until launch of MTSAT-1R

GOES-12

75 Deg. West

NOAA

Launched July 2001

Meteosat-5

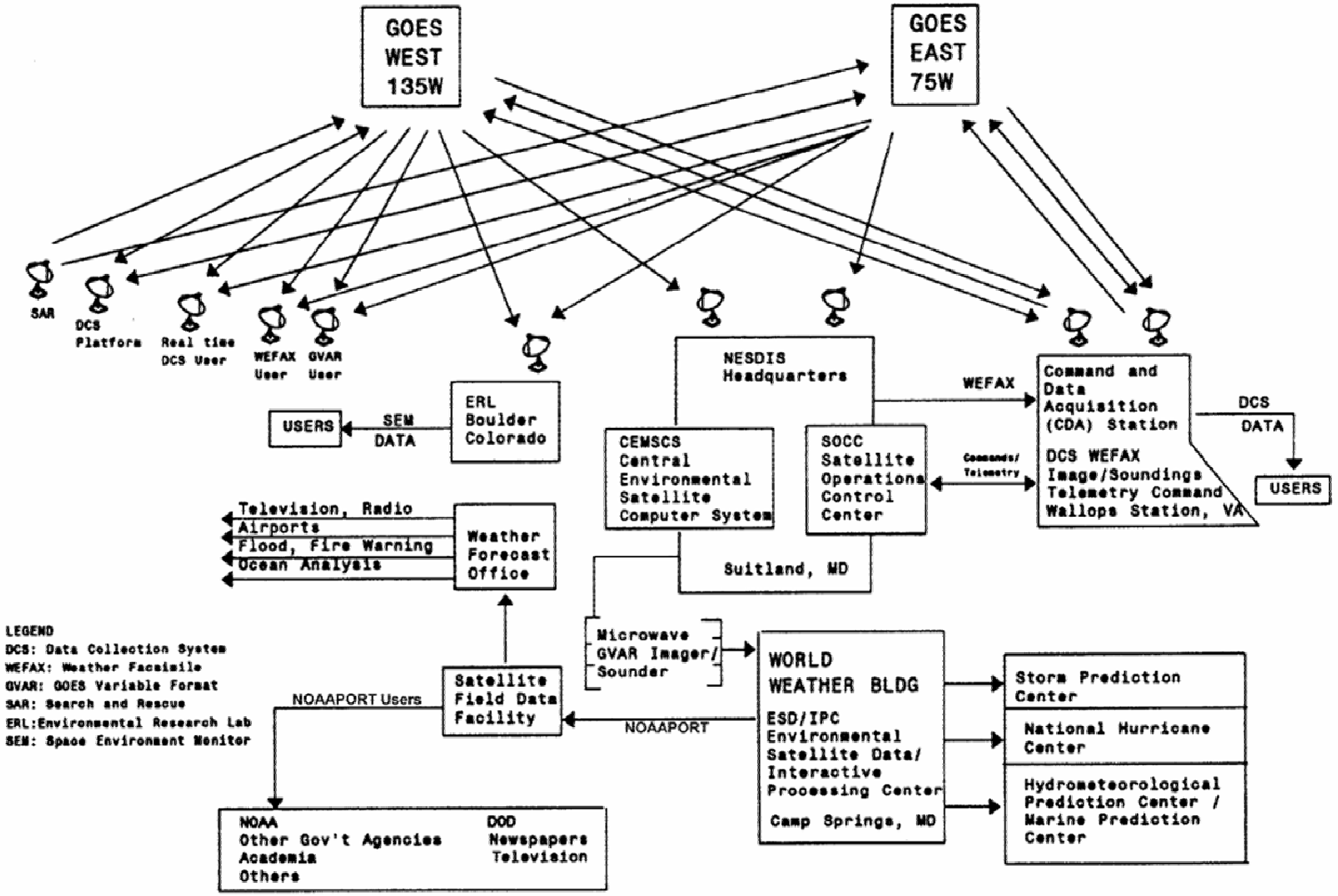
65 Deg. East

EUMETSAT

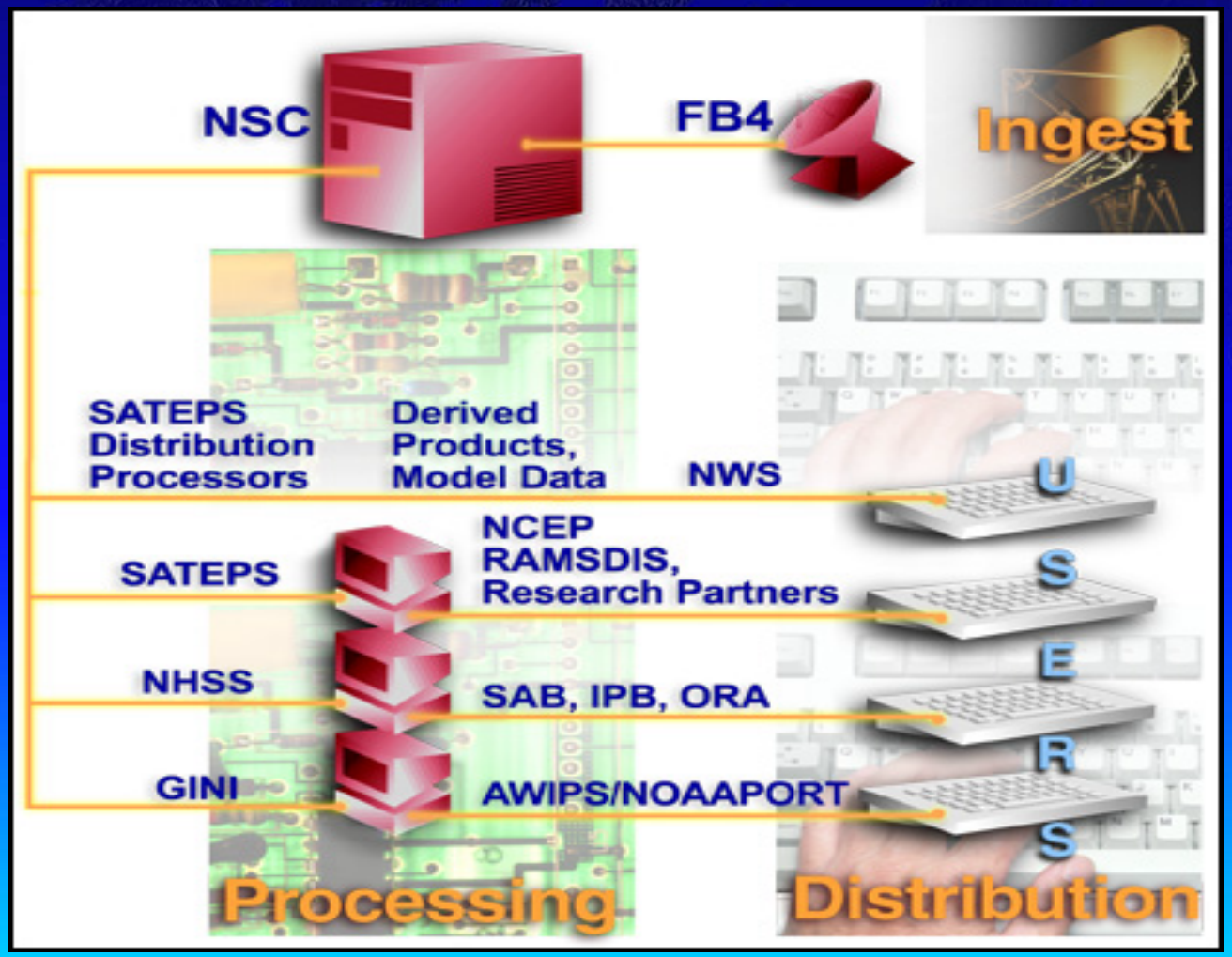
Data Used at SATEPS

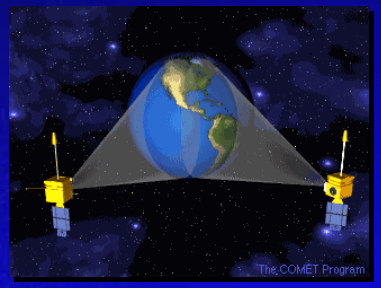
- **Geosynchronous**
  - GOES-12 at 75 degrees West
  - GOES-10 at 135 degrees West
  - Meteosat-7 at 0 degrees (MSG data coming soon)
  - GOES-9 at 155 degrees East
  - Meteosat-5 at 63 degrees East
- **Polar Orbiting**
  - DMSP 3 satellites
  - POES 3 satellites: NOAA-15, 16, and 17
  - NASA 4 satellites: TRMM, TERRA, AQUA, and QuickSCAT
- **Other**
  - Numerical Models
  - Family of Services
  - Lightning
  - Profiler

Dataflow for GOES

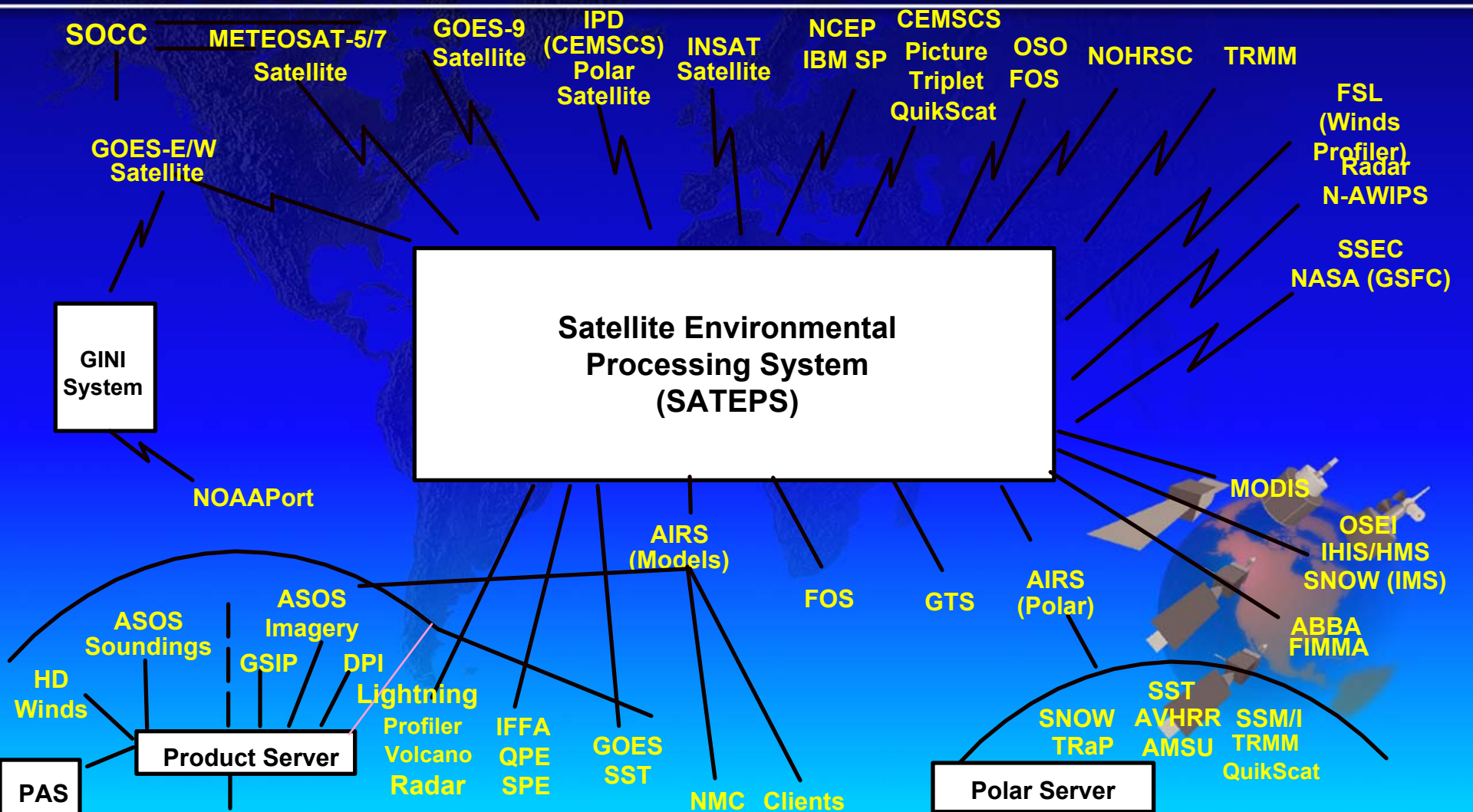


SATEPS Dataflow





Operational Production



SATEPS DATA Sources and Products

"RAW" Imagery Data

GOES-12
GOES-10
GOES-9
Meteosat-7
Meteosat-5
NOAA-17
NOAA-16
NOAA-15

SATEPS Processing

Applications

Global Geostationary Satellite Imagery
Tropical Cyclone Analysis
Volcanic Ash Detection and Tracking
Fire Monitoring and Analysis
Flash Flood Analysis
Satellite Imagery for AWIPS
Winds
ASOS Satellite Cloud Project
Sounding-Derived Products
Snow Cover
Special Events Imagery

"Ancillary" Data Input

Family of Services Data
Model Data

Forecast Data
Surface Data
Upper Air Data
Profiler Data

RADAR Data
RAOB/Radiosonde
Lightning Data
Ship Reports
Pilot Reports
Buoy Reports
MD Retrievals

Products

GOES-12, GOES-10, & MET-7 Remaps
GOES-9, MET-5 Remaps
GOES-12 and GOES-10 High Density Winds
GOES-12 and GOES-10 ASOS SCP
GOES-12 and GOES-10 DPI
GOES-12 and GOES-10 PW Soundings
GOES-12 and GOES-10 IFFA
GOES-12 and GOES-10 Product Archive (NCDC)
NOAA-16/17 Derived SNOW-IMS
GINI: AWIPS Predefined Digitally Remapped Sector Products
METEOSAT Remaps
SSM/I WINDS, Rain Rate, Total Precipitation Water, Snow
POES Passes and Composites
SSM/I Composites
GOES SST

Satellite Environmental Processing System (SATEPS)

- SATEPS System Description
  - Satellite Environmental Processing System is a group of distributed processing systems located on 5th floor of NOAA Science Center – 24 x 7 ops
  - Current configuration consists of 150 computing systems that include Dell/Intel, IBM/SP & SGI Origin systems
  - Operating systems LINUX, AIX & IRIX
  - Current processing capacity is peak theoretical .4 Tflops
  - Current storage capacity is ~7TB
  - Functions include ingest, processing, distribution (including network hosting) and interactive analysis

McIDAS Hardware

- Ingestors (8)
  Remap/Serve
  2 SDIs for each
  - GOES East 188 GB^{d}
  - GOES West 141 GB^{d}
  - Met 7/5 → 26 GB^{d}
  - ~~GOES-9/Mosaics~~
- Polar Server 10 GB^{d}
  - AVHRR & SSM/I
- GINI
  - Produces imagery for AWIPS


Ingestors

Remappers/
Servers

GINI

McIDAS Hardware

Client Side

- Currently moving from Solaris to Linux operating systems

- **7+ Operational Workstations**

  Pentium 3 - 350 Mhz, 384 Mb RAM, 8GB

  640 Frames of Imagery/Graphics at 640 x 455 pixel resolution

  Dual 1.2 GHz, 3+ GB RAM, 40 GB

  640 Frames of Imagery/Graphics at 1265 x 948 pixel resolution

  - Numerous Development Platforms
    - Solaris, Linux, SGI

Data Distribution

- Standard Imagery and DPI
  - Push
    - AWIPS – Dedicated T1s to NCF in Silver Spring, then through NWS NOAAPORT delivery system
      - Data used in NWS WFOs for life and property forecasting
  - Pull
    - NAWIPS – IBM SPs
    - McIDAS ADDE
      - Local users plus AWC, TPC, SSEC, CIRA, others

Data Distribution

- Product Servers - Pull
  - For many automated products
    - Winds, soundings
      - Formats: BUFR, GRIB
- NWSTG FOS - Push
  - For text products
    - Volcano, Heavy Precipitation, Tropical, ASOS SCP
- Internet / Web Servers - Pull
  - Imagery and Text
    - Also – product files
      - McIDAS AREA, MD

Satellite Analysis Branch & Interactive Processing Branch

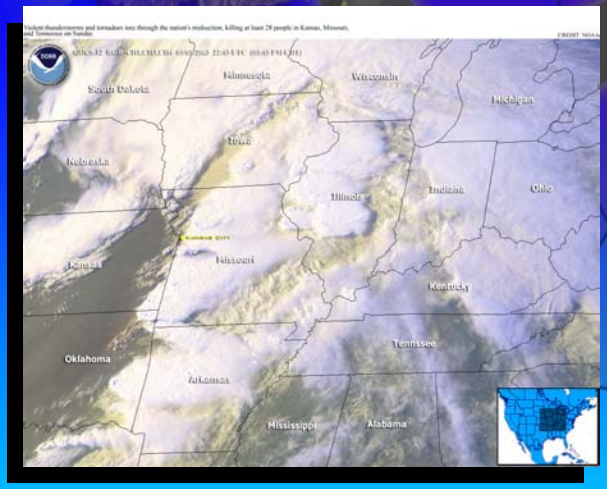
Serves as NOAA/NESDIS focal point for providing high quality, real time global satellite-derived products, interpretive analyses, and other information.

These services, provided by professional meteorologists, support domestic and international meteorological warnings and forecasts, numerical weather models, climate analyses, and other initiatives within the Federal government.

Satellite Analysis Branch

Hazard monitoring and mitigation performed through human generated environmental analyses of satellite data drive the meteorologists in the Satellite Analysis Branch (SAB). This office is staffed 24 hours per day, 7 days per week to monitor global environmental satellite data for natural and man made hazards to assist NOAA's mission to protect life and property. The branch focuses on 5 main hazard areas: Volcanic Ash, Tropical Storms, Heavy Precipitation, Snow & Ice Cover, Fires and Smoke.

Interactive Processing Branch



A team of highly skilled environmental scientists from many disciplines make up the Interactive Processing Branch (IPB). IPB works closely with research institutions to bring the latest technology to the forefront of NOAA's Satellite and Information Services. The scientists within IPB implement cutting edge satellite analysis techniques into interactive tools, many for use by the SAB. They also manage the implementation and production of a large suite of environmental products created automatically from each satellite data ingest. IPB provides support to SAB analysts by developing tools such as the Hazard Mapping System to enable SAB scientists to interactively view a vast array of satellite data and perform complex analyses using a single graphical system.

Satellite Services Division

Key Mission Areas:

- Numerical Weather Prediction Support
- NWS Field Offices & National Centers
- Hazards Support
- Special Events/Operational Significant Events Imagery
- NOAA Coast Watch
- NOAA Web Services
- Central Satellite Data Distribution

SSD Products and Services

Mission Area: Numerical Weather Prediction Support

Function:

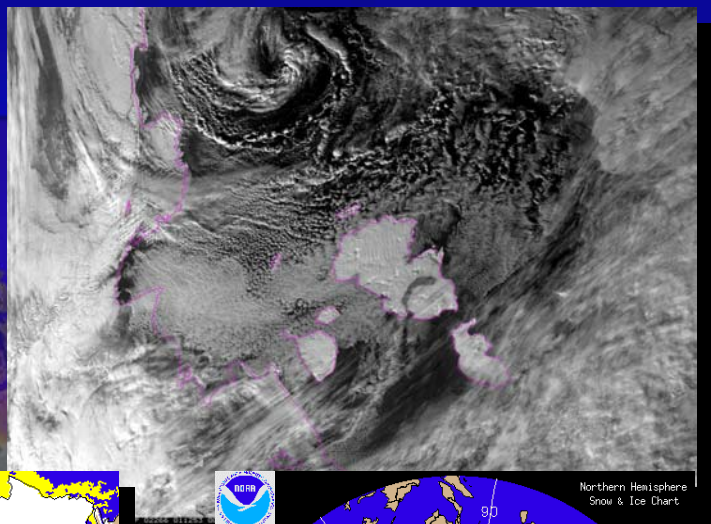
To provide global operational automated satellite products to support NCEP's numerical weather models

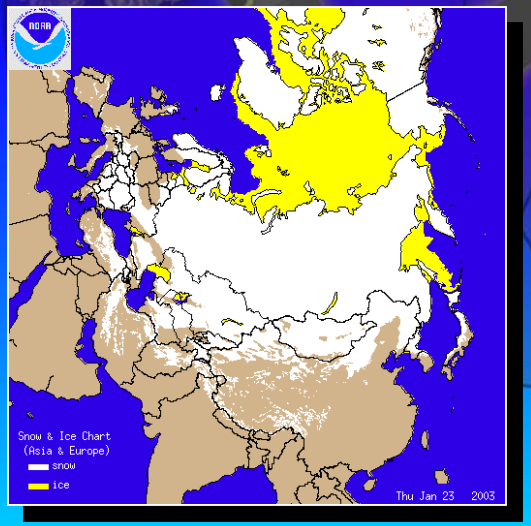
Example of Automated Product Applications and Services:

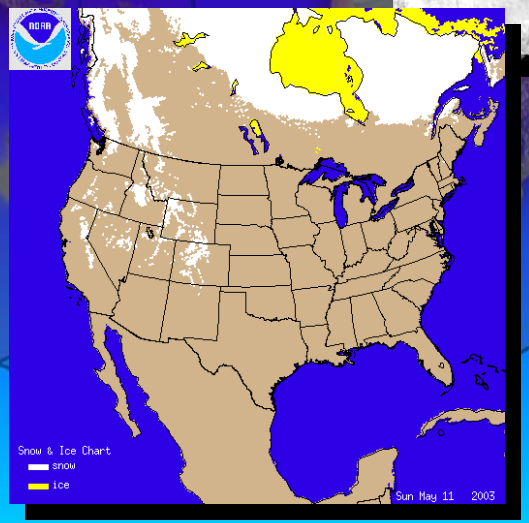
- **Daily snow cover**
- **GOES Soundings**
- **High density winds**

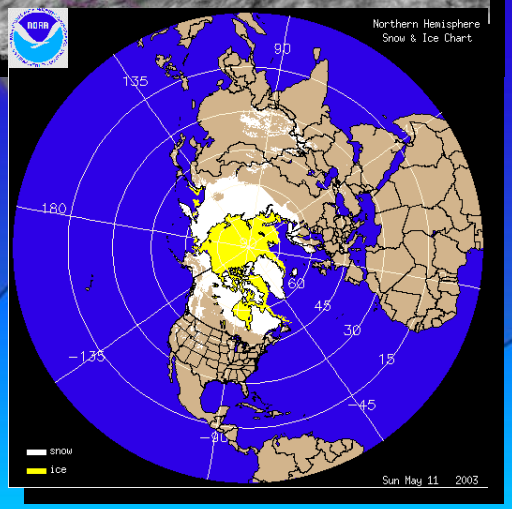
Snow/ Ice Program

Snow and Ice: Daily analyses of snow and ice from global geostationary and polar orbiting satellite imagery are generated by SAB meteorologists. This data is collected by NWS numerical weather models as an important input into the global weather forecast system.

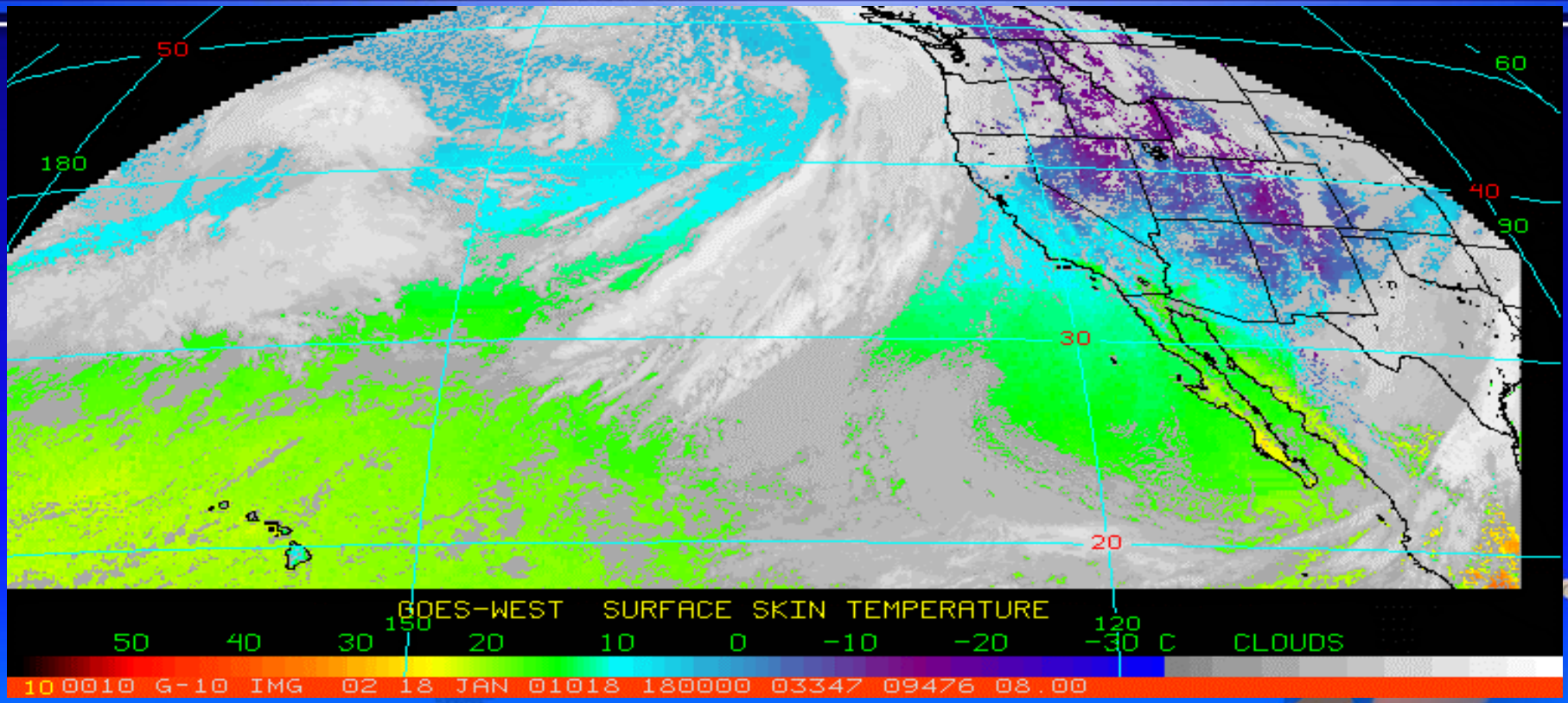






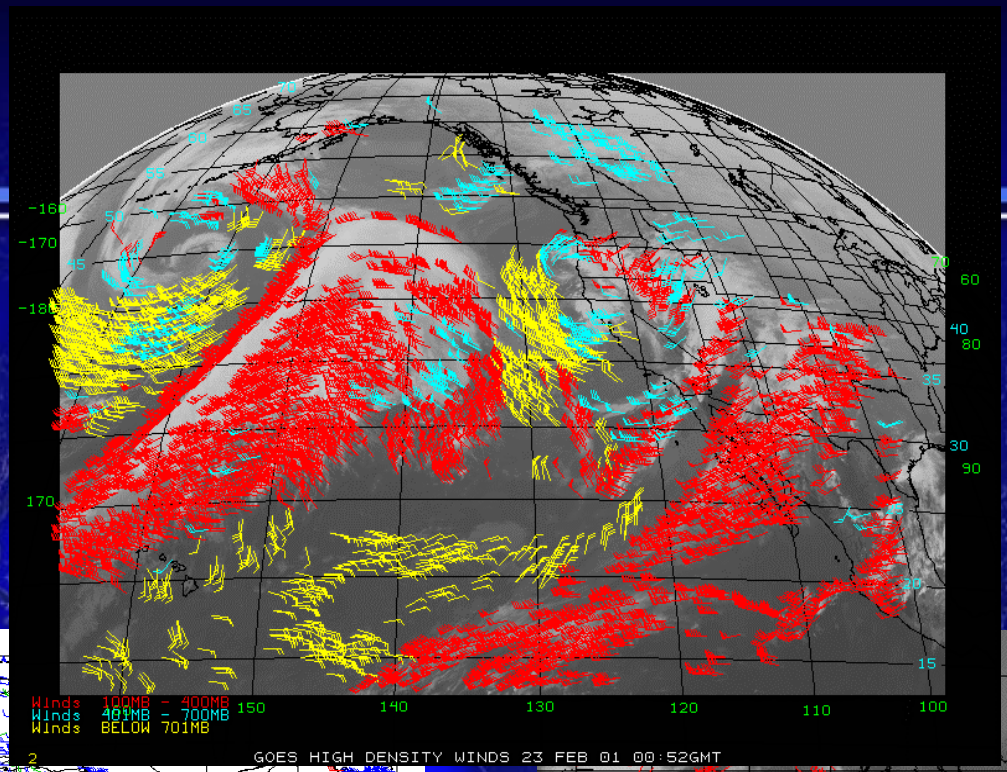


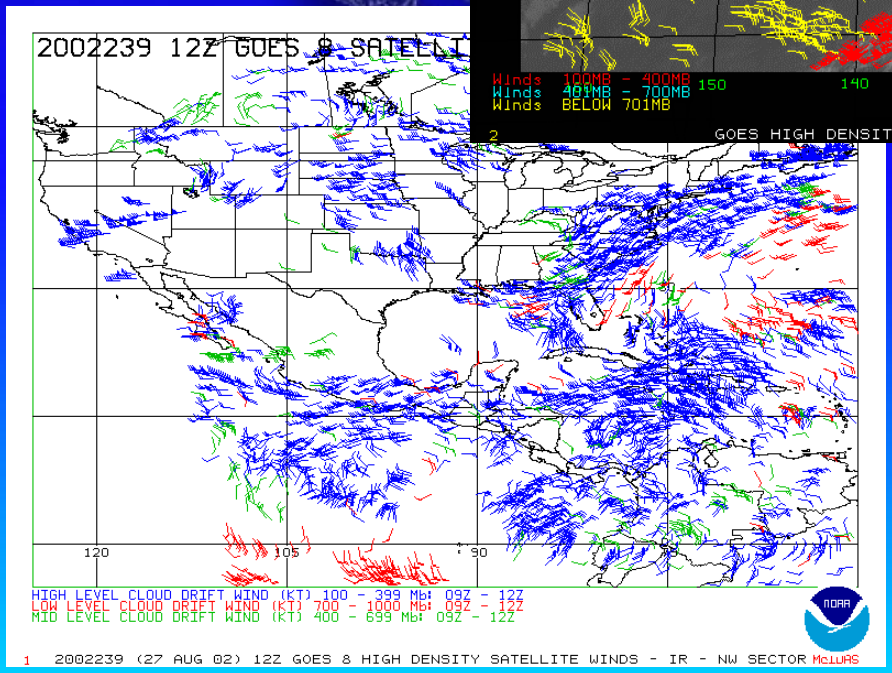
GOES-10 Derived Product Imagery (DPI)

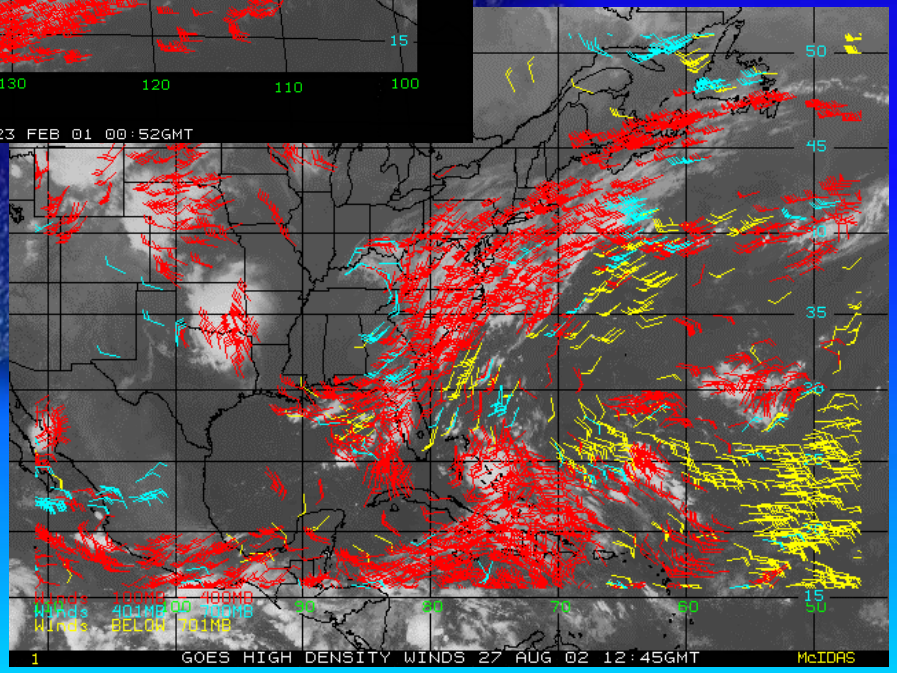


Location: Northern Pacific Ocean	***Data Source: GOES-10***
Product Type: Derived Product Imagery	***Availability: Hourly***

GOES Derived Winds







SSD Products and Services

Mission Area: NWS and National Center Support

Function:

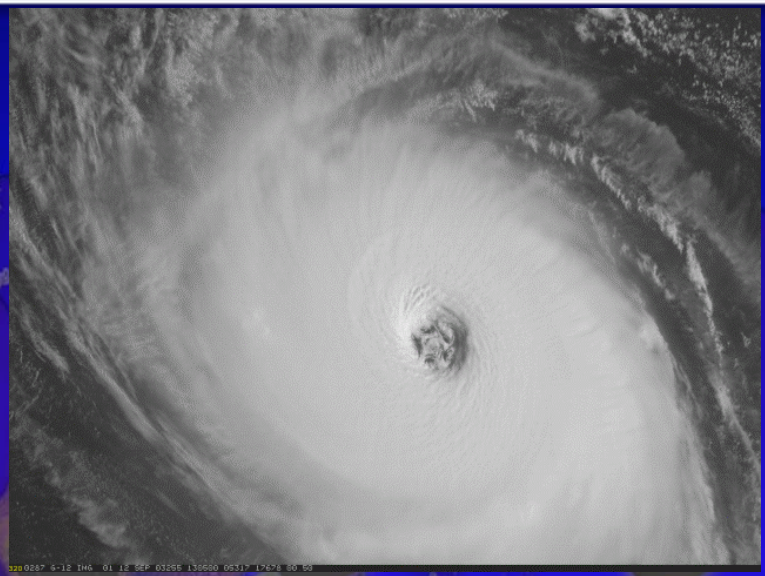
To provide NWS forecast and field offices, and national centers with operational satellite-derived products and services

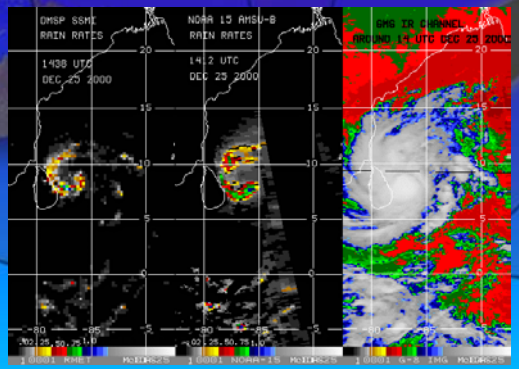
Product Applications and Services

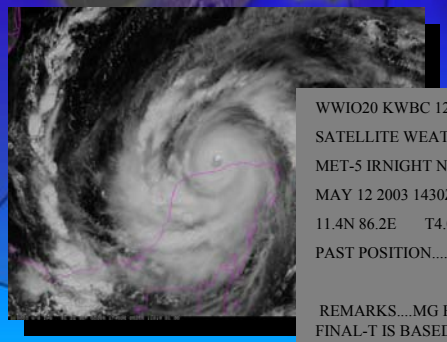
- Tropical Cyclone positioning
- Heavy precipitation estimates (flash floods)
- Remapped GOES, POES IR, VIS, & water vapor

Tropical Cyclone Program

Tropical Storms: Global Geostationary and Polar Orbiting microwave satellite data are monitored for the formation, movement, and intensity of tropical storms, hurricanes, and typhoons. Routine analyses of these storms are relayed to the National Weather Service and other international agencies that analyze and forecast these dangerous storms.







WWIO20 KWBC 121458

SATELLITE WEATHER BULLETIN

MET-5 IRNIGHT NORTH INDIAN OCEAN .

MAY 12 2003 1430Z .

11.4N 86.2E T4.0/4.0/S0.0/12HRS 01B .

PAST POSITION....10.9N 85.7E 12/0230Z VIS/IRDAY

10.7N 86.4E 11/1430Z IRNIGHT

REMARKS....MG EMBEDDED CENTER PRODUCES A DT=4.0. THE FINAL-T IS BASED ON DT..PAT AND MET. SYSTEM COULD POSSIBLY BE FORMING A CLOUD FILLED EYE. .

POSITION ACCURATE WITHIN 40 NMI. .

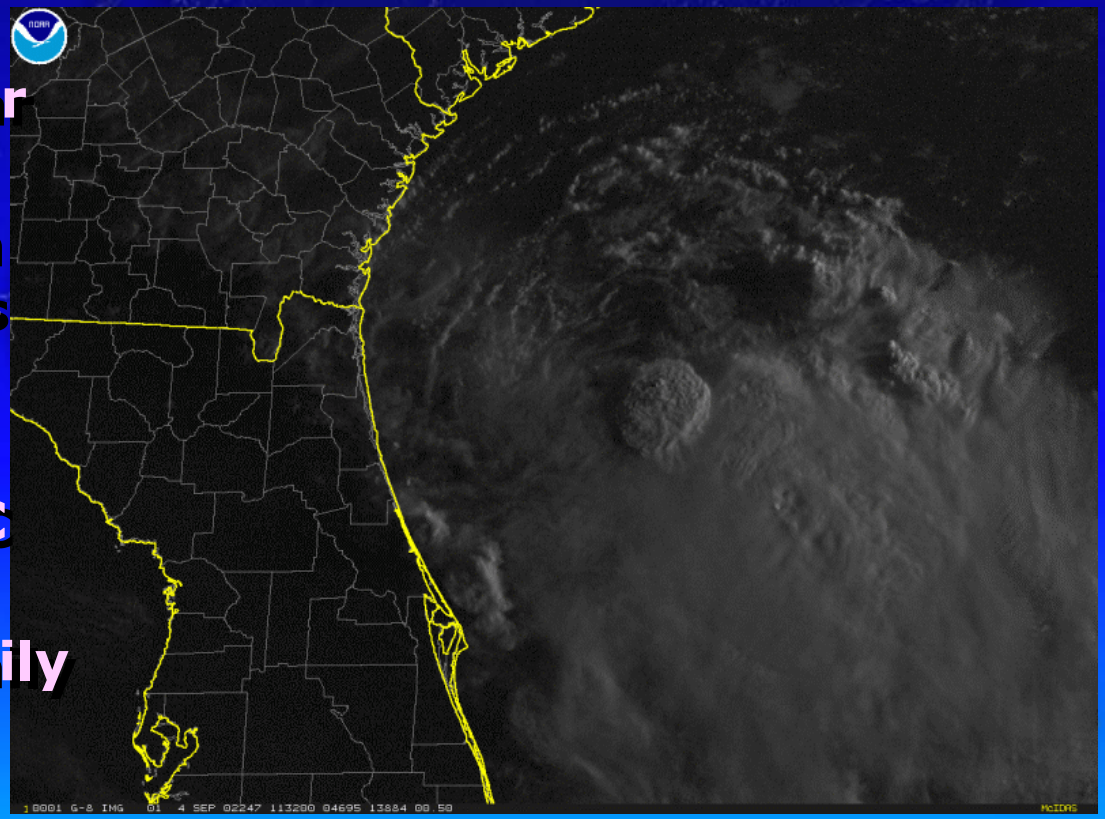
THE NEXT BULLETIN WILL BE ISSUED BY 12/2200Z.

Tropical Cyclone Program

Tropical Storm Positioning and Intensity

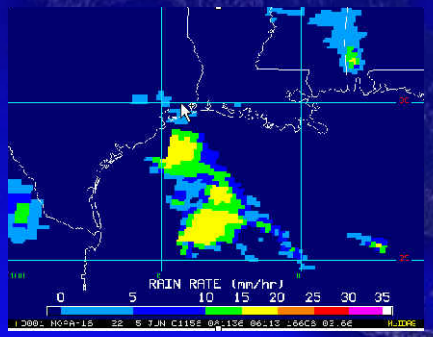
- Global analysis of Geostationary and Polar Orbiting data
- Satellite fixes on storm centers every six hours

- Western Hemisphere – data sent to NHC, CPHC
- Eastern Hemisphere – data sent to NOAA Family of Services as text bulletin



Tropical Cyclone Program

Tropical Rainfall Potential (TRaP)



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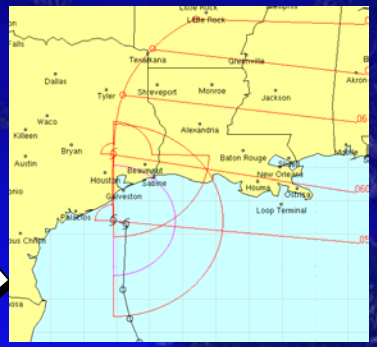
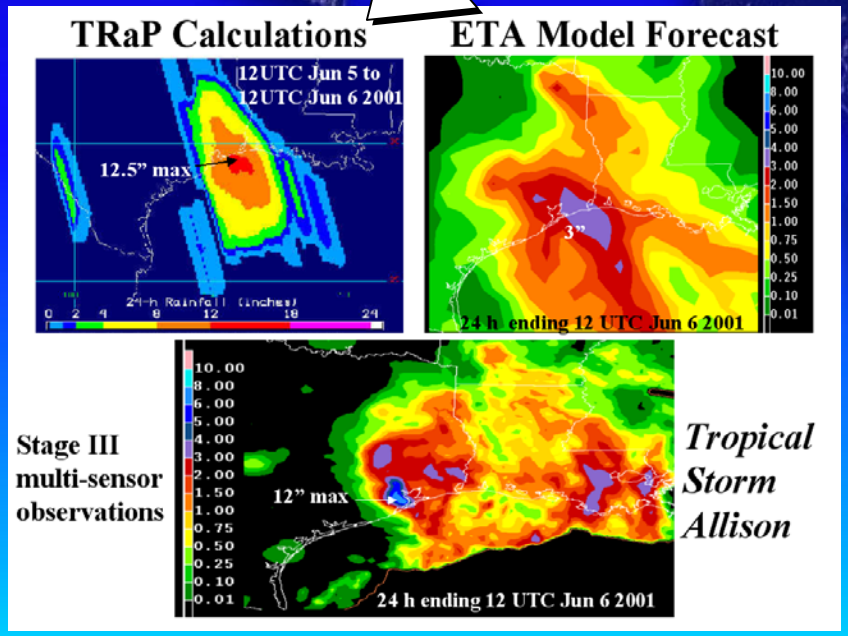
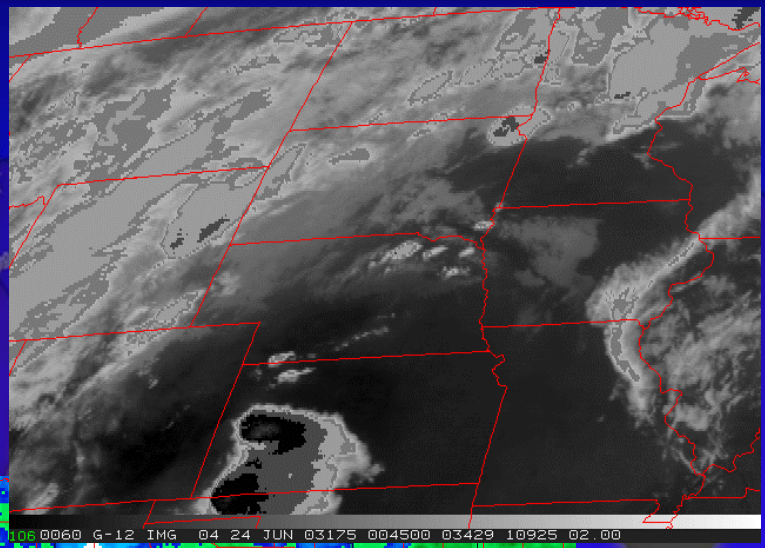




- Calculates an objective rainfall potential map from the latest Rain Rates
- Extrapolates using McIDAS to 24 hours by every 6 hours using the latest NHC, CPHC, or JTWC forecast track
- Now fully automated – will run for every forecast and every latest rain rate produced
- Can be used with SSM/I, AMSU, TRMM, or GOES Multispectral Rain Rates

Satellite Precipitation Analysis

Flash flooding: The deadliest form of hazardous weather in the U.S. is flash flooding. SAB monitors high resolution GOES satellite imagery over the continental U.S. and performs rainfall and snowfall estimates, both graphically and in descriptive text. These estimates are transmitted to National Weather Service Weather Forecast Offices (WFOs) for meteorologists who issue flash flood warnings. SAB also routinely analyzes various satellite imagery for briefing NWS hydro-meteorological forecasters to aid in the preparation of quantitative precipitation forecasts (QPF)



SATELLITE PRECIPITATION ESTIMATES..05/28/03 0425Z
SATELLITE ANALYSIS BRANCH/NESDIS---NPPU---TEL.301-763-8678 VALUES ARE MAX OR SGFNT EST. OROGRAPHIC CORRECTION IN AUTO-ESTS LATEST DATA USED: GOES-12 0345Z

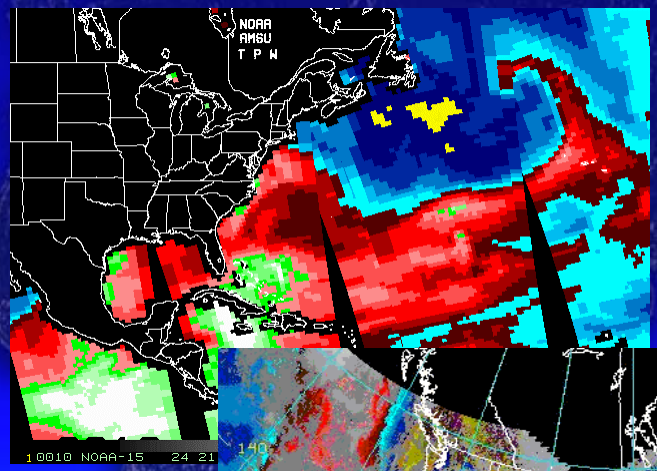
LOCATION...CENTRAL AND SOUTHERN FLORIDA... .

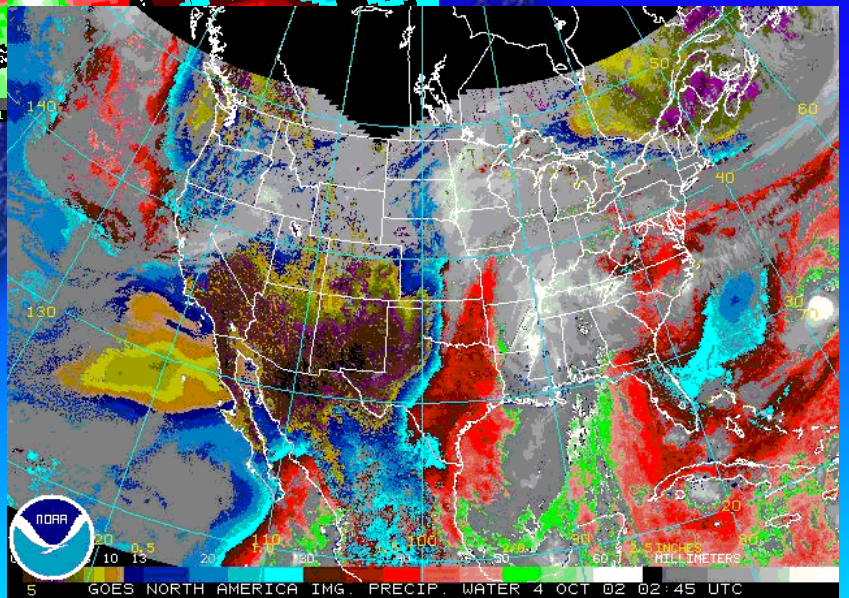
EVENT...LEADING TROPICAL BOUNDARY SURGING NORTH AIDING IN CONTINUED CELL TRAINING...

Precipitation Program Derived Products

Heavy Rain/Snow Analysis and NOWCasting

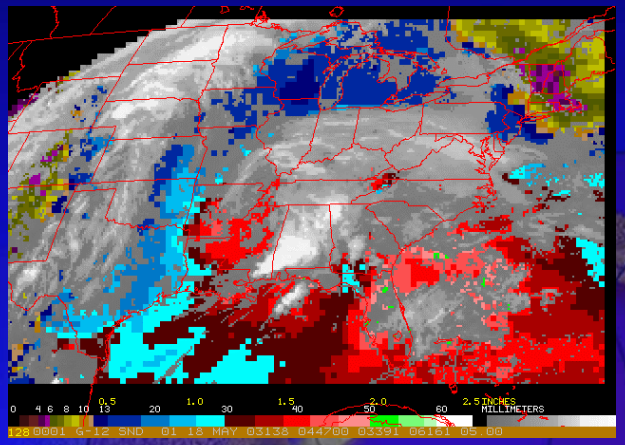
- Looping McIDAS imagery used to identify movements and trends in specific meteorological parameters such as Precipitable Water, Rain Rate, Cloud Liquid Water, Jet Streams, waves, Vorticity centers, etc.
- Analysis of data given to NWS HPC as part of Precip forecasts and to NWS offices in Satellite Precip. Estimate Messages





GOES Derived Products

GOES Products useful in precipitation and flood forecasting…

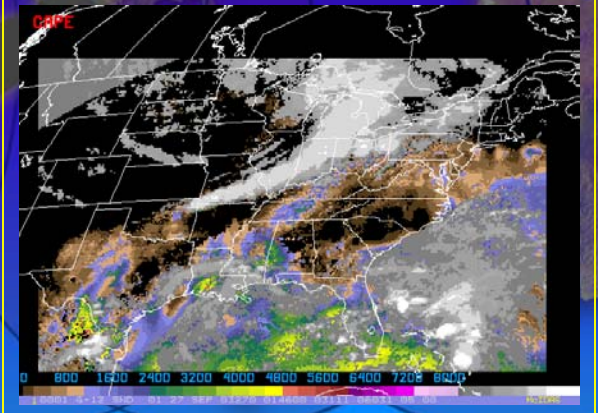


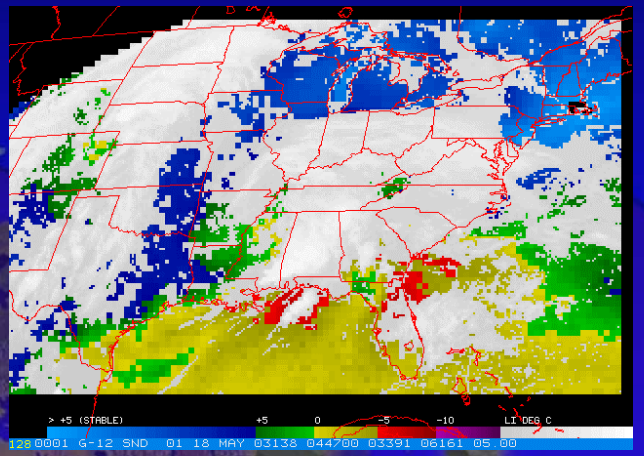
Total Precipitable Water (TPW):

Potential amount of water released from an atmospheric column if completely condensed; useful for quantitative precip. estimates.

Convective Available Potential Energy (CAPE):

Amount of "stored buoyant" energy of atmosphere; used to identify possible intense storms.





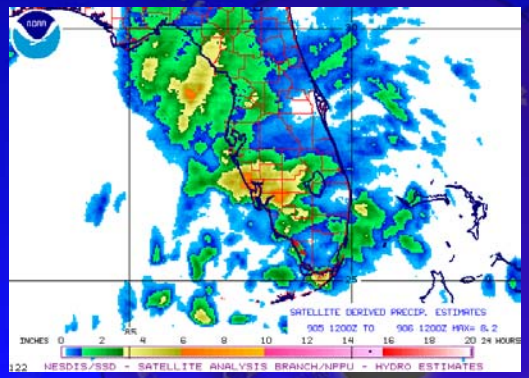
Lifted Index (LI):

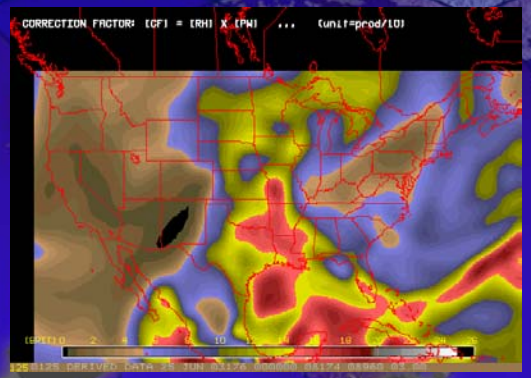
Index for estimating atmospheric stability; useful for locating areas with greatest storm potential.

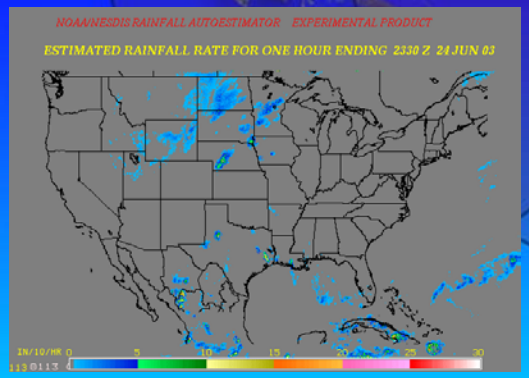
Satellite Precipitation Analysis

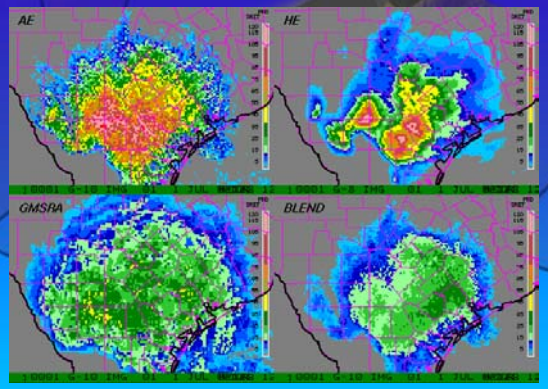
Satellite based quantitative precipitation estimates

The AutoEstimator and Hydro-Estimator









An automated product that takes satellite, radar, and model input to create a precipitation estimate based on cloud top temperature, moisture correction, and ground terrain.

Produces estimates every 15 minutes

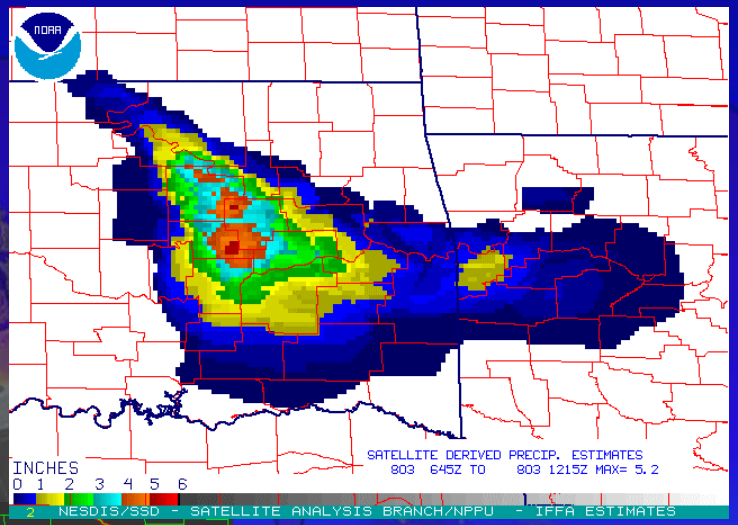
Reduces the time needed by the satellite analyst to perform manual IFFA estimations

Satellite Precipitation Analysis

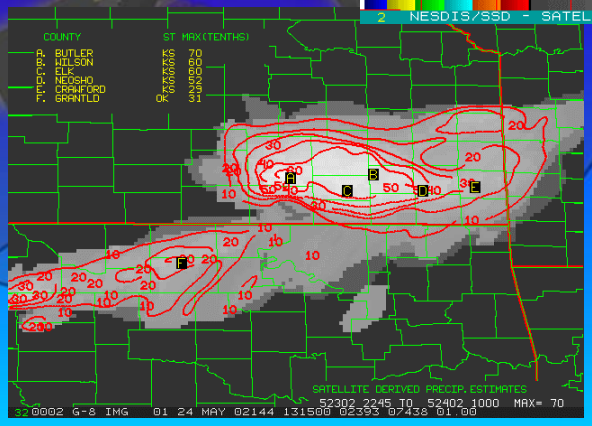
Satellite based quantitative precipitation estimates

The Interactive Flash Flood Analyzer (IFFA)

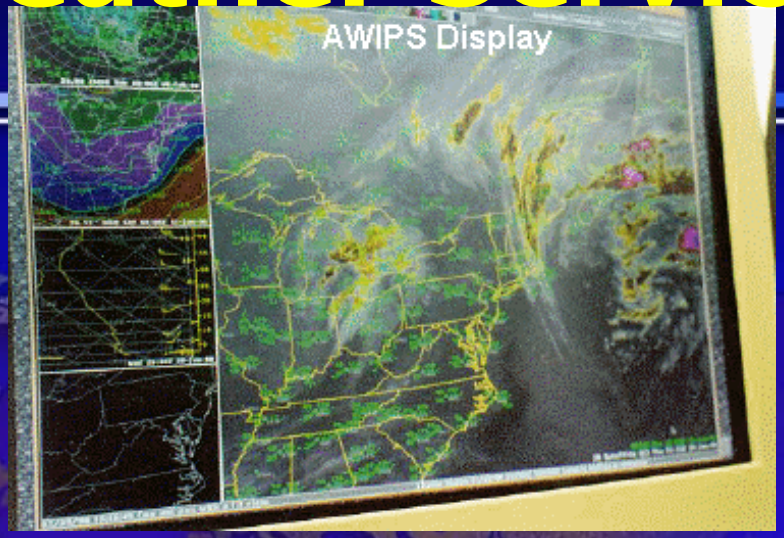
A McIDAS based software suite that allows an analyst to manually draw on top of satellite imagery using half hourly estimates from the Scofield Convective Technique (Scofield '87). Half hourly grids are saved then added together and re-mapped over a specific area.



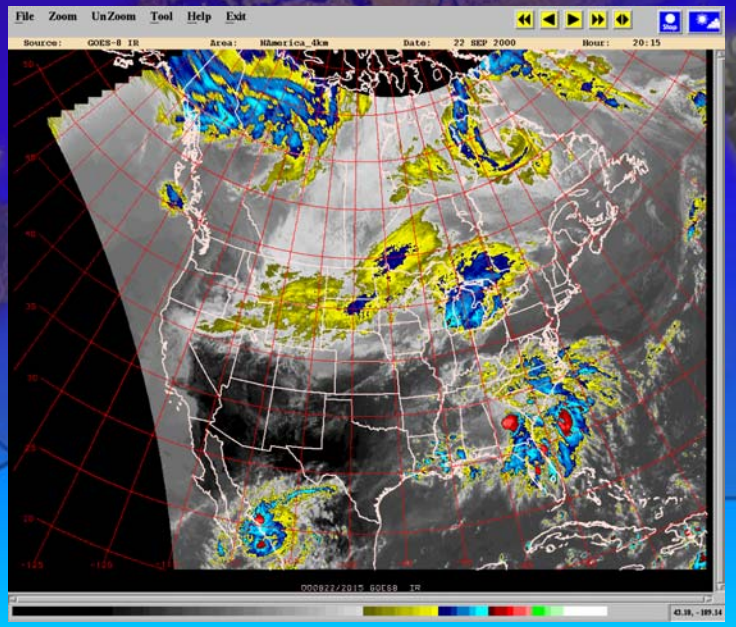
IFFA Satellite Precipitation Estimates are transmitted to NWS Field Offices using AWIPS and Internet. 6 and 24 hourly totals are sent to River Forecast Centers.



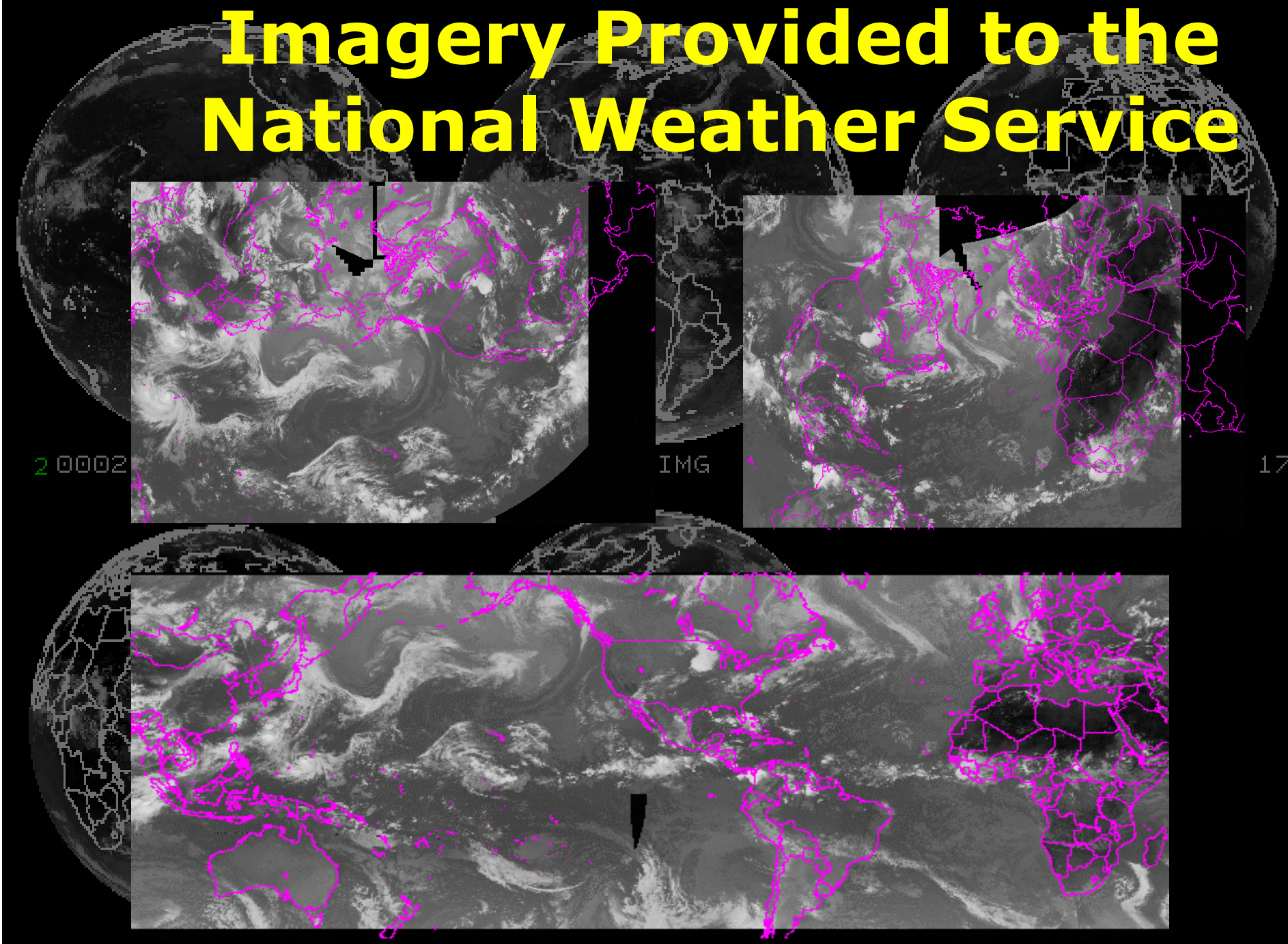
Imagery Provided to the National Weather Service



- **AWIPS –**
  - **NWS Weather Forecast Offices**
  - **http://www.nws.noaa.gov**
- **N-AWIPS**
  - **National Centers**
  - **http://www.ncep.noaa.gov**



Imagery Provided to the National Weather Service



SSD Products and Services

Mission Area: Natural Hazards Support

Function:

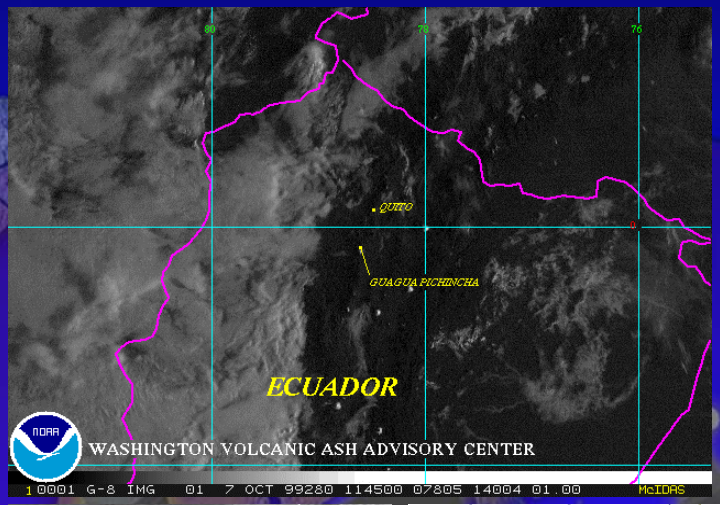
To provide interpretative analysis support in monitoring global natural hazards

Product Applications and Services

- Volcanic Ash Advisories
- Smoke and Fire Analysis
- Tropical Cyclone Monitoring
- Heavy precipitation Estimates

Volcano Program

Volcanic Ash: The SAB serves as part of the Washington Volcanic Ash Advisory Center (VAAC). GOES, POES, and ancillary data are monitored 24x7 and advisories on recent eruptions, including speed, direction, and height, are issued as text bulletins to Meteorological Watch Offices (MWOs) and civilian and military aviation interests, so that airlines can avoid flying through hazardous ash clouds.



VOLCANIC ASH ADVISORY

ISSUED: 2002JAN23/2045Z VAAC: WASHINGTON .
VOLCANO: POPOCATEPETL 1401-09

LOCATION: 1901N9837W AREA: MEXICO

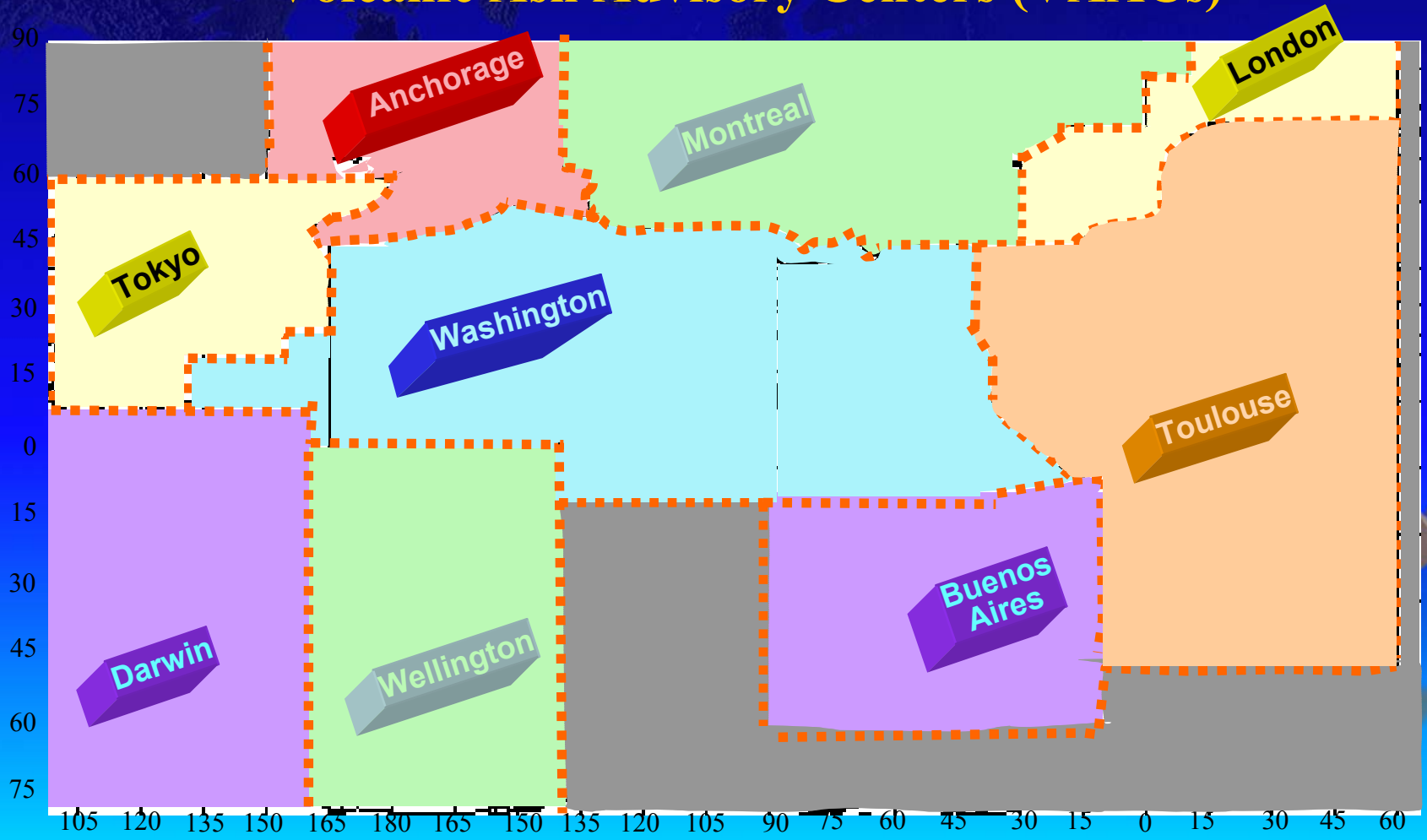
.SUMMIT ELEVATION: 17930 FT (5465 M) .

ADVISORY NUMBER: 2002/009 .

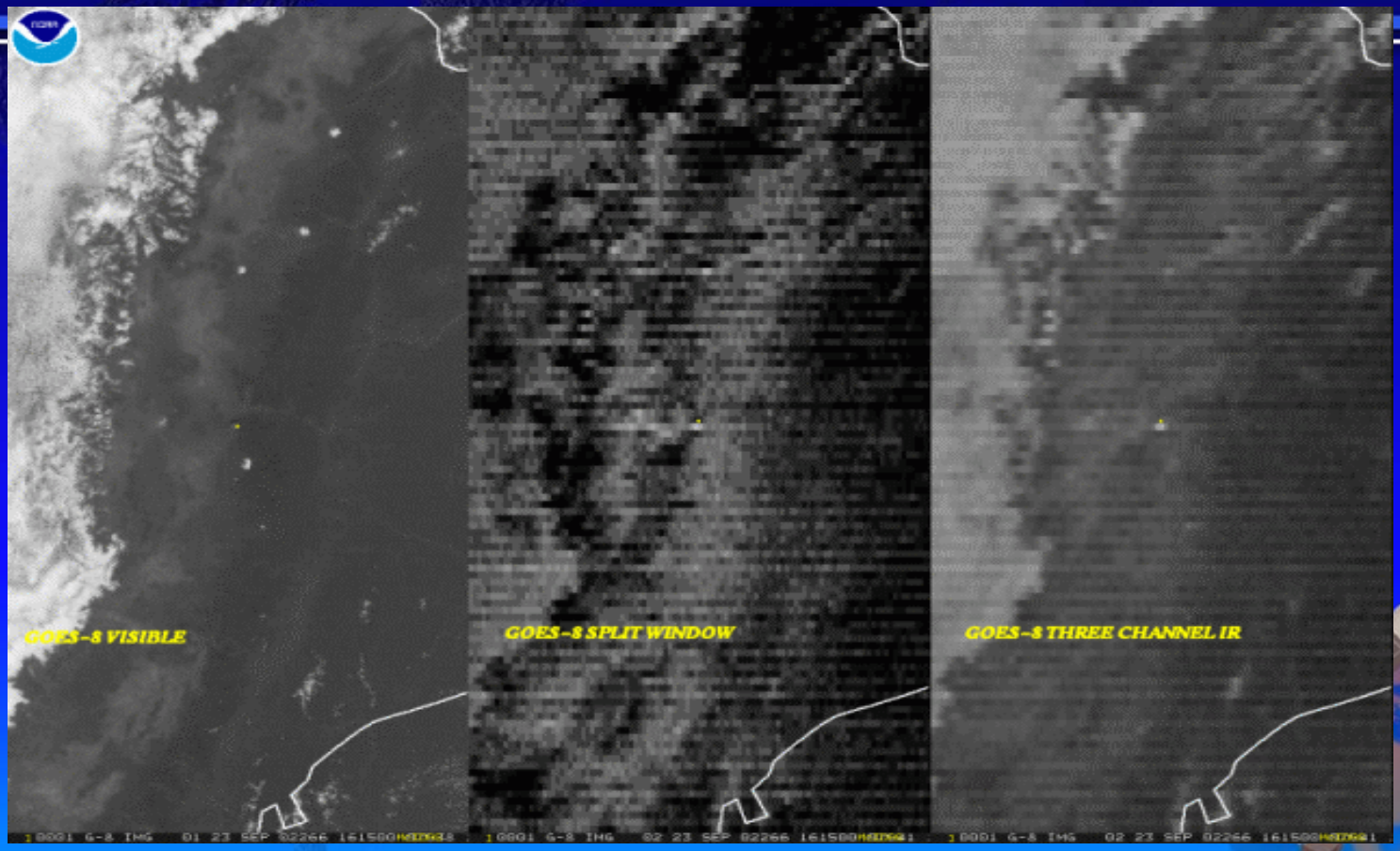
INFORMATION SOURCE: GOES-8 VISIBLE AND INFRARED AND MULTISPECTRAL IMAGERY. MEXICO CITY METEOROLOGICAL WATCH OFFICE….

Volcano Program

Volcanic Ash Advisory Centers (VAACs)



Volcano Program



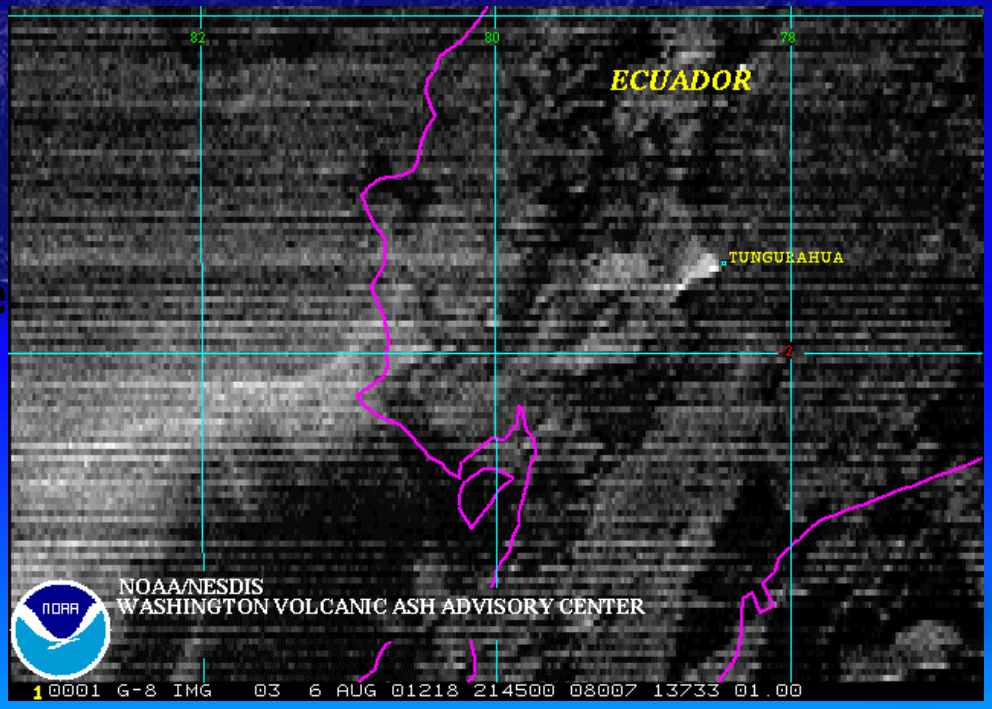
SAB uses multispectral imagery derived from GOES channels to enhance ash detection

Volcano Program

Volcanic Ash Analysis

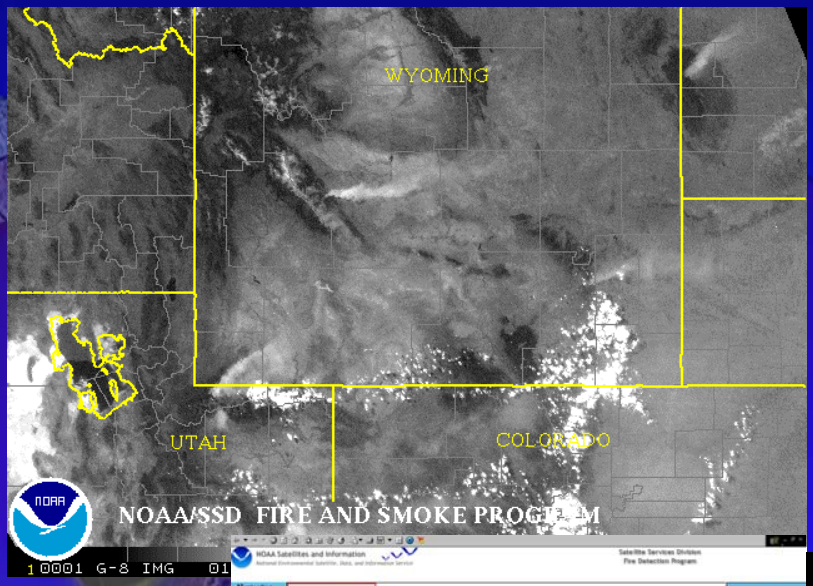
Ash Analysis using Principle Component Imagery (PCI)

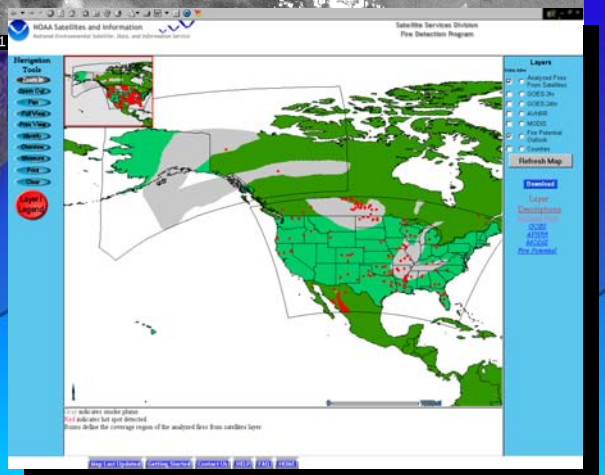
- McIDAS analysis of three infrared channels (3.9, 10.7, and 12 μm) output with weights applied to each channel based on the eigenvector/eigenvalue analysis of the original imagery.
- Very useful for isolating ash radiance when environment does not remain constant



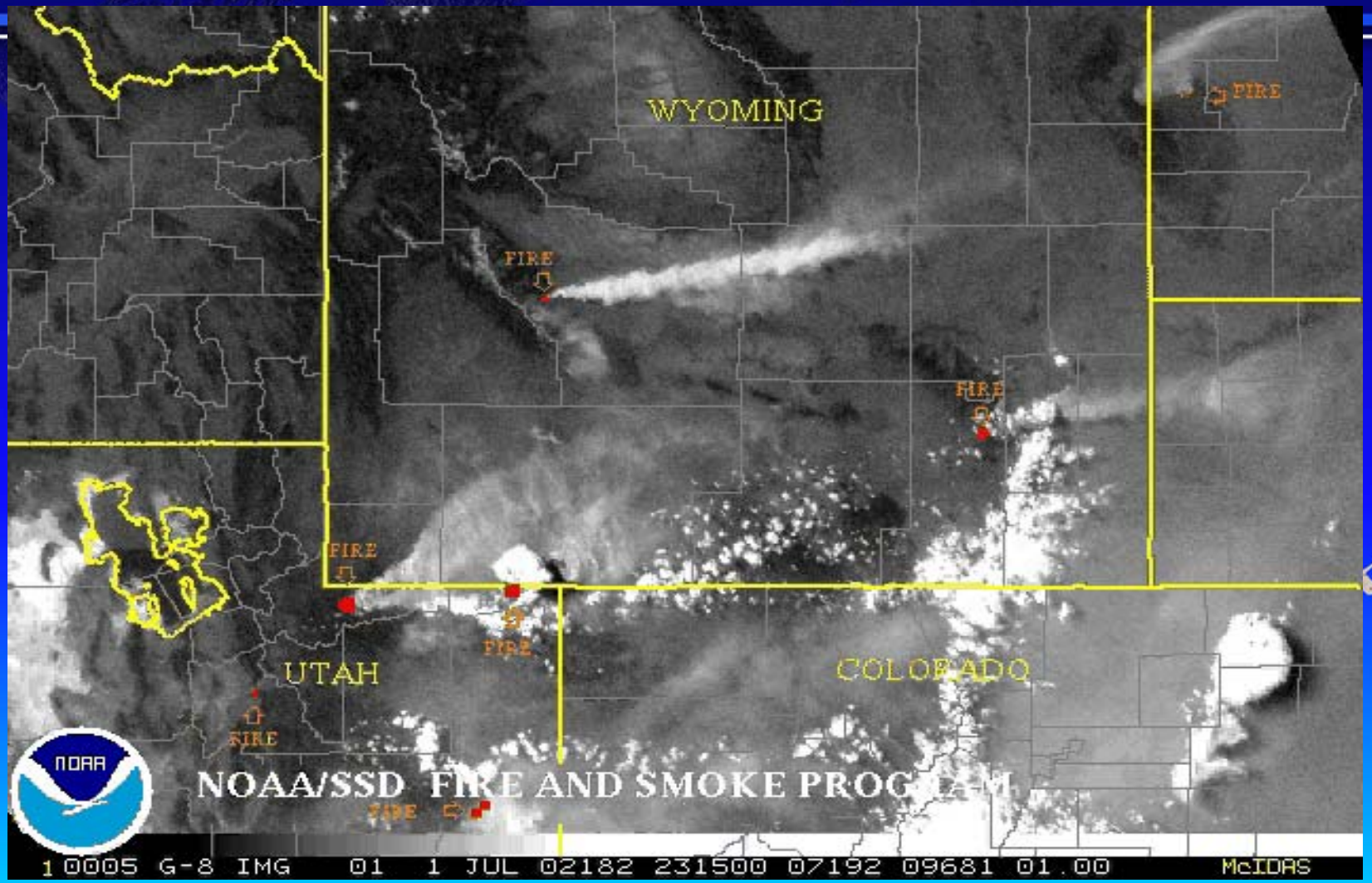
Fire Program

Fires and Smoke: Using infrared imaging technology from GOES, POES and non-NOAA polar orbiting satellites (MODIS), SAB analysts can pinpoint wildfires in the U.S. to an accuracy of 1 km. Visible sensors can show large smoke plumes from those fires. Users such as the National Interagency Fire Center in Boise, Idaho and the Storm Prediction Center use analyses to aid in the detection and mitigation of devastating wildfires.



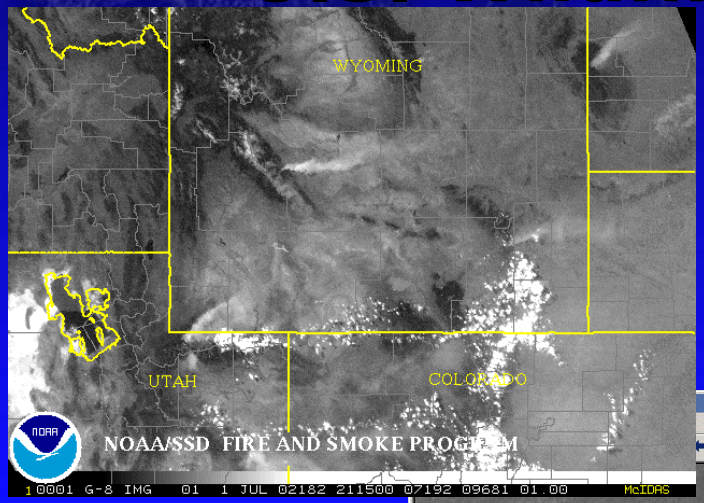


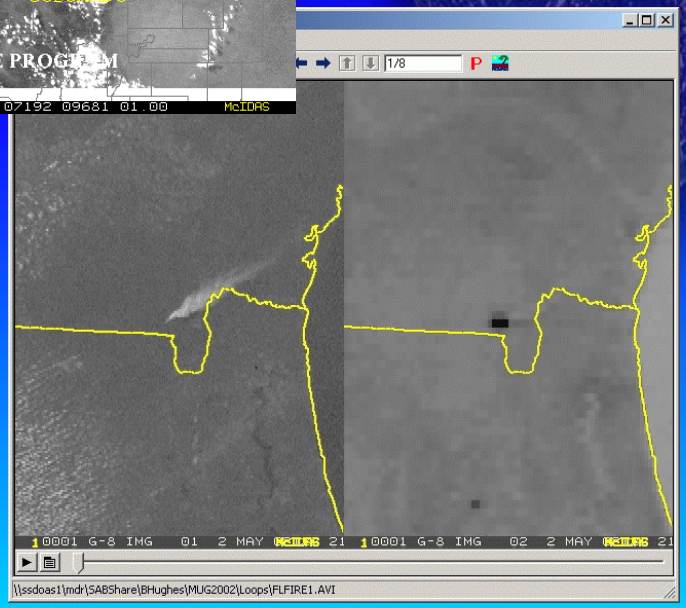
Fire Program



Fire Program

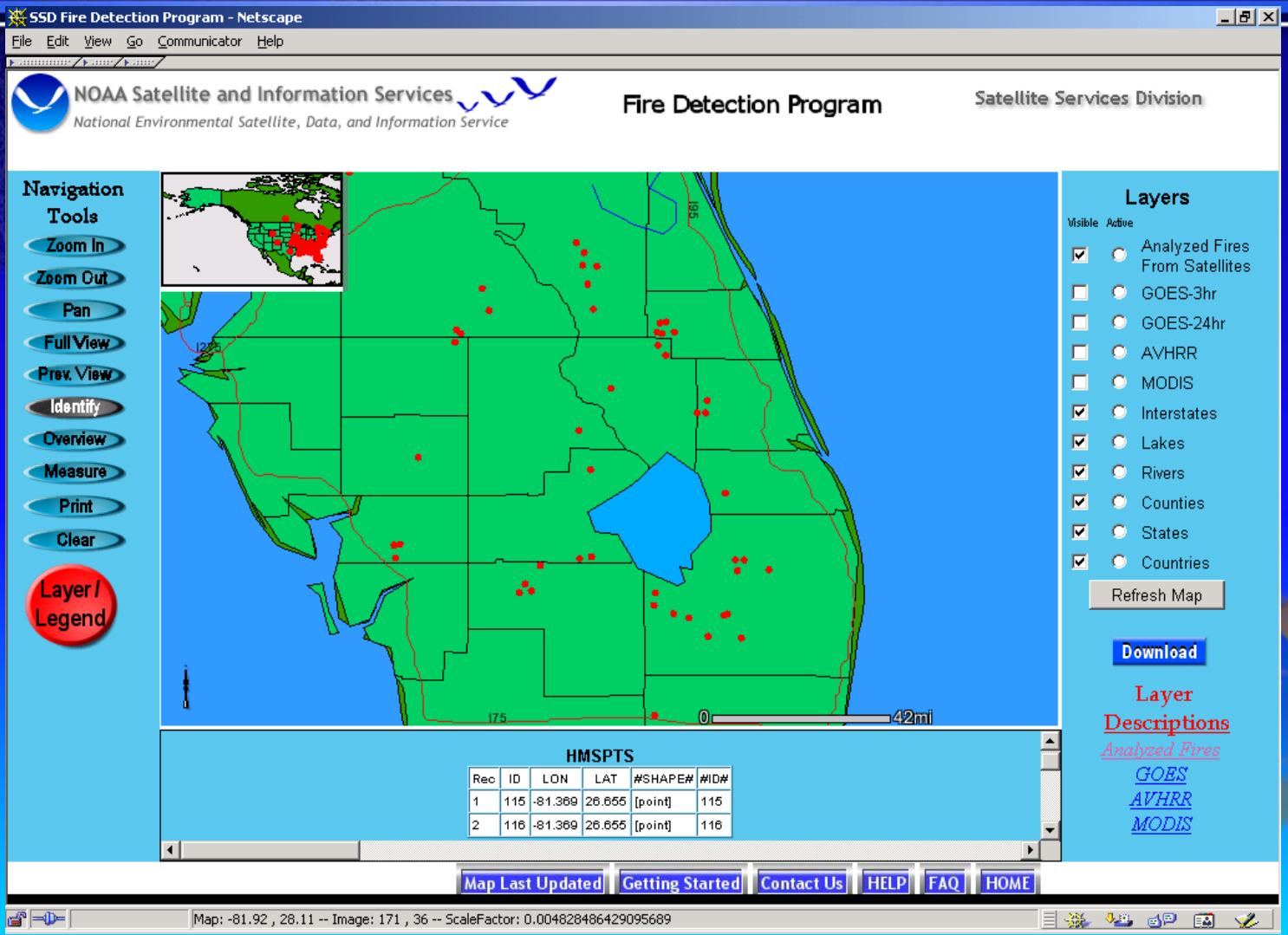
U.S. Wildfire and Smoke Analysis





- Program was initiated in 1998 in response to the devastating Florida fires and the thick smoke over Houston, TX from Mexican fires.
- SSD produces a fire/smoke analysis 2x/day using GOES and POES (AVHRR and MODIS) analyzed imagery and automated points (FIMMA, ABBA)

Fire Program



SSD Products and Services

Mission Area: Special Events/Operational Significant Events Imagery Monitoring

Function:

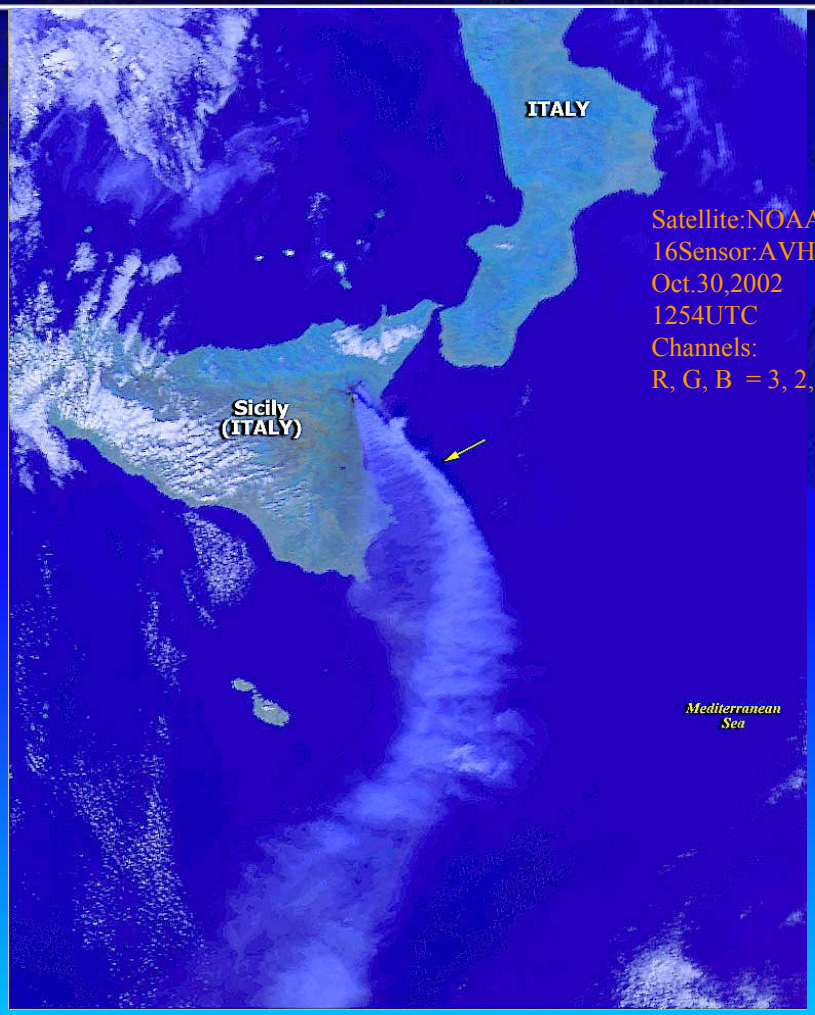
To provide specialized, high resolution imagery for significant natural and anthropogenic events on a world-wide basis

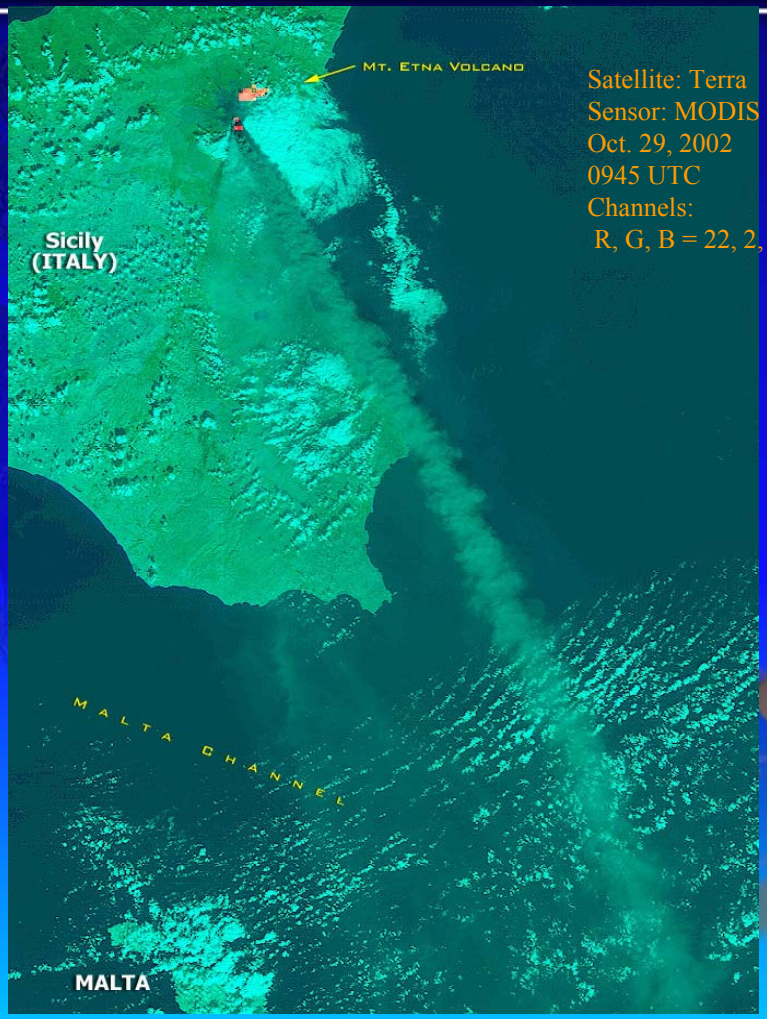
Product Applications and Services :

- Events include, but not limited to
  - Dust storms
  - Wildfires
  - Sea ice events
  - Severe storms
  - Other hazards including volcanic ash and tropical cyclones

OSEI Documents Natural Hazard Events

The Operational Significant Events Imagery (OSEI) program posted imagery of many natural disasters worldwide, e.g., these images of an eruption of Mt. Etna, Sicily which began on Oct. 29, 2002 and continued for several weeks, devastating the Town of Catania and causing mass evacuations. Left: NOAA-16, Advanced Very High Resolution Radiometer (AVHRR); right: Terra, Moderate Resolution Imaging Spectroradiometer (MODIS). Airborne ash is gray, heat from lava flows is red.





SSD Products and Services

Mission Area: NOAA Coast Watch

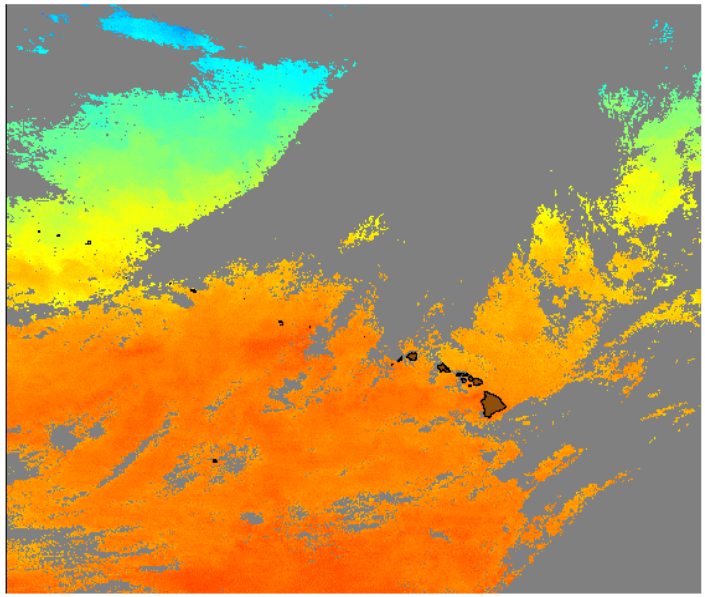
Function:

To provide operational satellite-derived products and in-situ data to Federal , state, and local marine scientists and coastal resource agencies and managers

Product Applications and Services

- Operational sea surface temperatures
- Ocean Color
- High resolution IR, VIS and water vapor image sectors

SSD CoastWatch



CoastWatch provides operational satellite-derived products and in-situ data to Federal , state, and local marine scientists and coastal resource agencies and managers

SSD Products and Services

Mission Area: NOAA Web Services

Function: To provide public and private access to satellite-derived products and services produced by Satellite Services Division

SSD Web Sites and Services

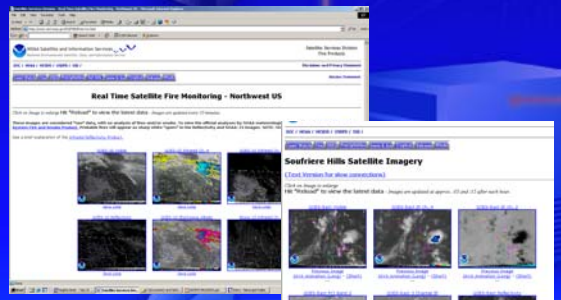
- Volcanic Ash Advisories
- International GOES imagery browser
- Operational significant imagery browser
- Coast Watch
- Hazard Analyses
- GOES special bulletins, eclipse & dissemination schedules

SSD Web Access

The Geostationary Satellite Server (www.goes.noaa.gov)

Real time satellite data over large regions.

Viewing global or synoptic scale events using visible, infrared, and water vapor images and loops.

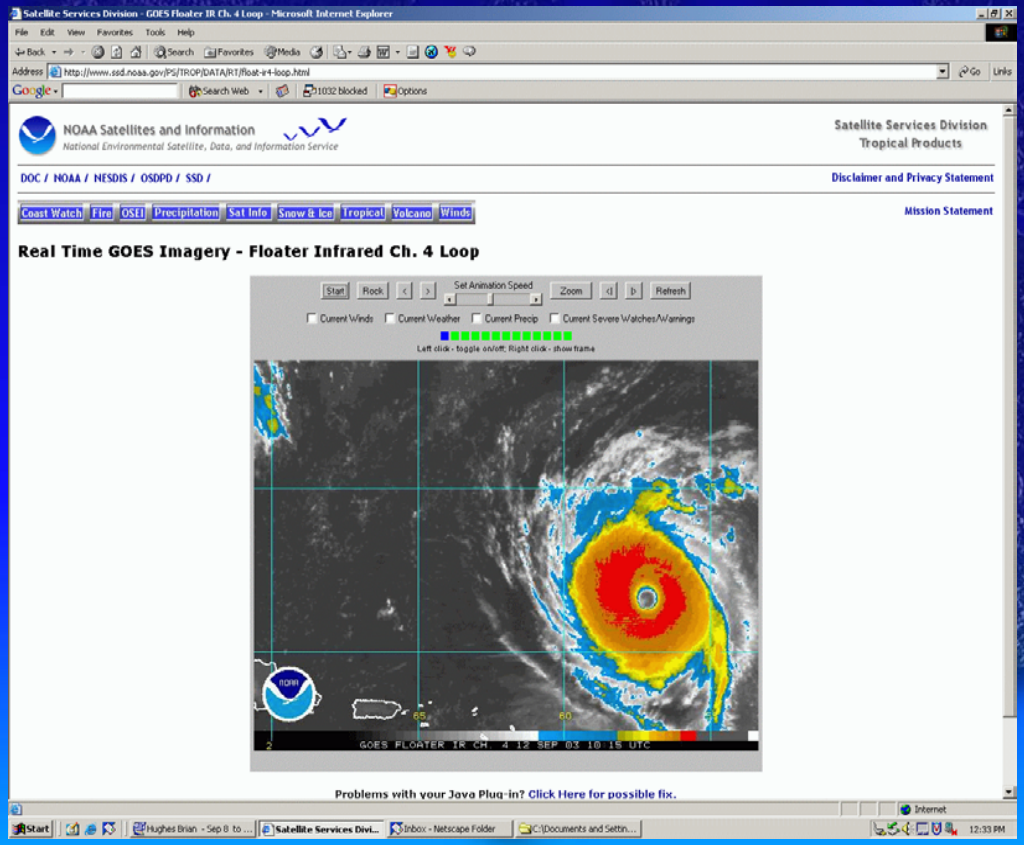


Specialized imagery and synoptic scale viewing of events on the Satellite Services Division (www.ssd.noaa.gov) web pages. Derived products for hazard monitoring (fire, volcano, tropical, heavy precipitation)

Operational Significant Events Imagery (www.osei.noaa.gov)

High resolution, manually generated, high quality false color images for media and presentations.

SSD Web Access

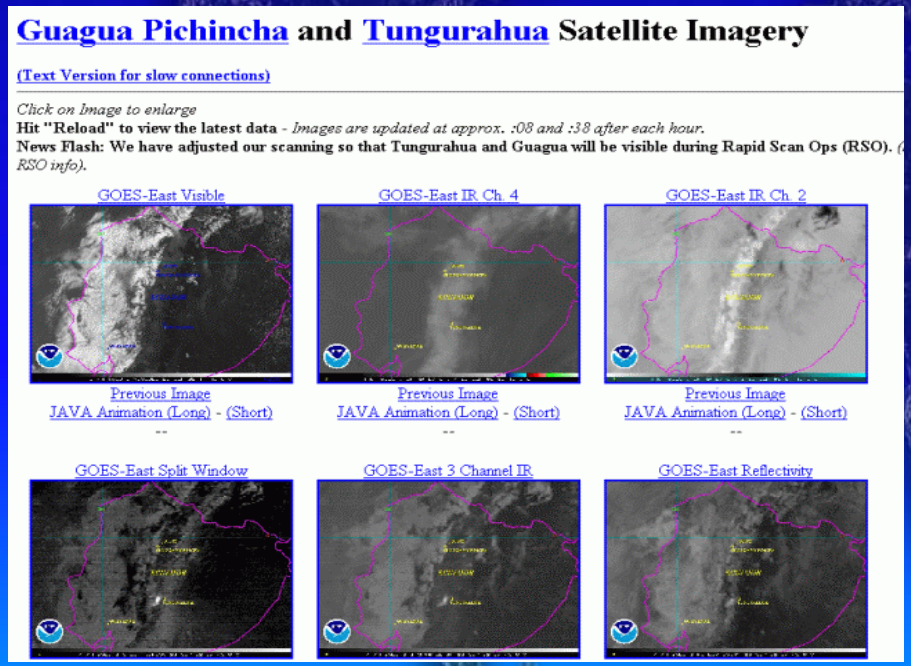


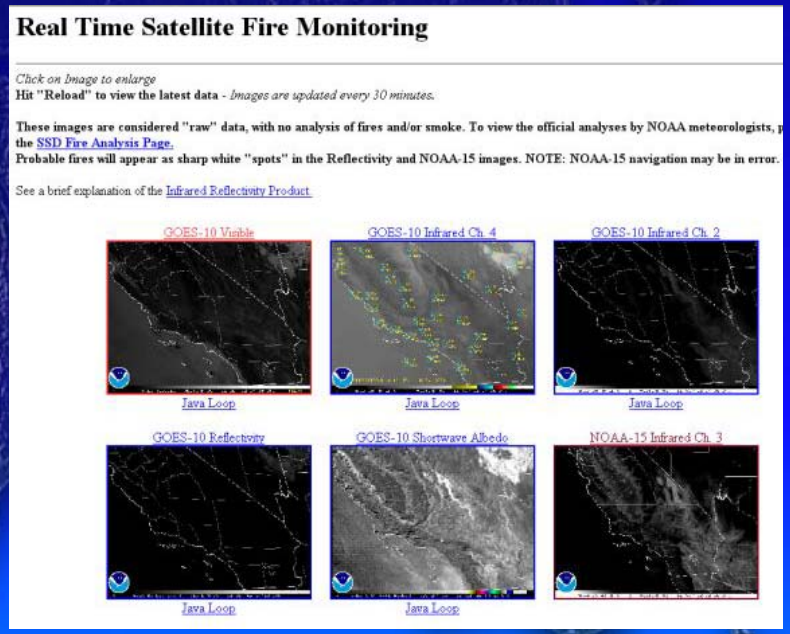
- Looping of images using the AnimationS applet developed by Tom Whittaker of SSEC.
- Replaces JavaScript Animation
- Client side applet
- "McIDAS" type functions – looping, overlays, enhancements, etc.

SSD Service to the Public

Hazard Mitigation: Providing valuable information to the customer

Volcano Monitoring



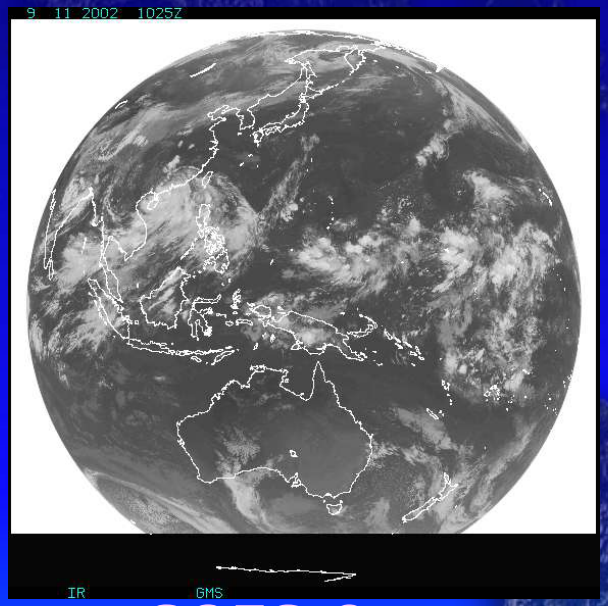


Fire and Smoke imagery

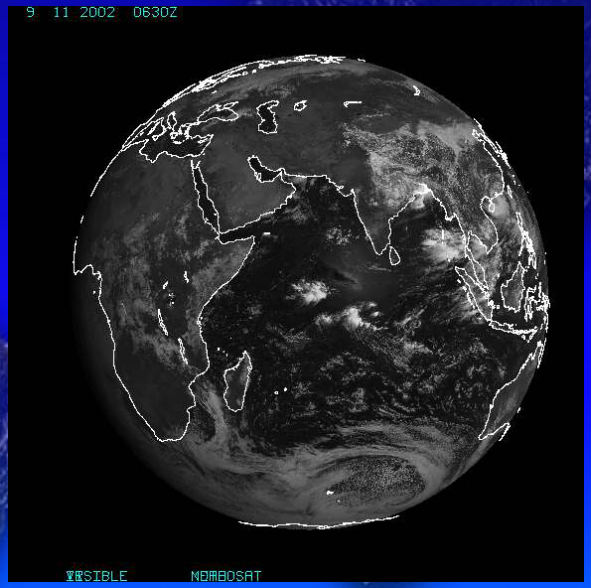
http://www.ssd.noaa.gov/

SSD Service to the Public

Global Satellite Views

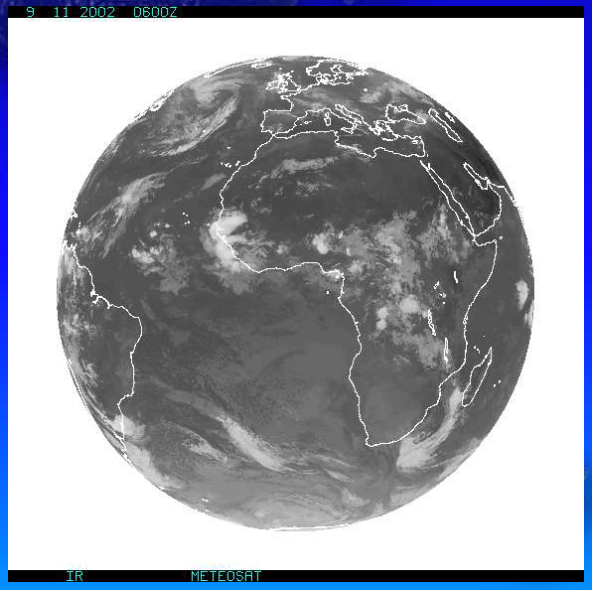


GOES-9



METEOSAT-5

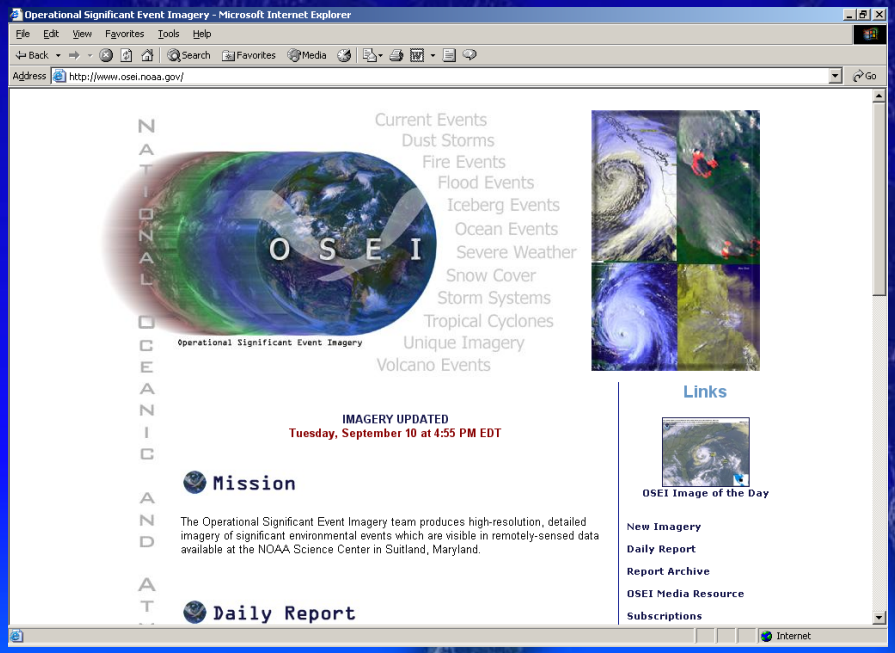
METEOSAT-7

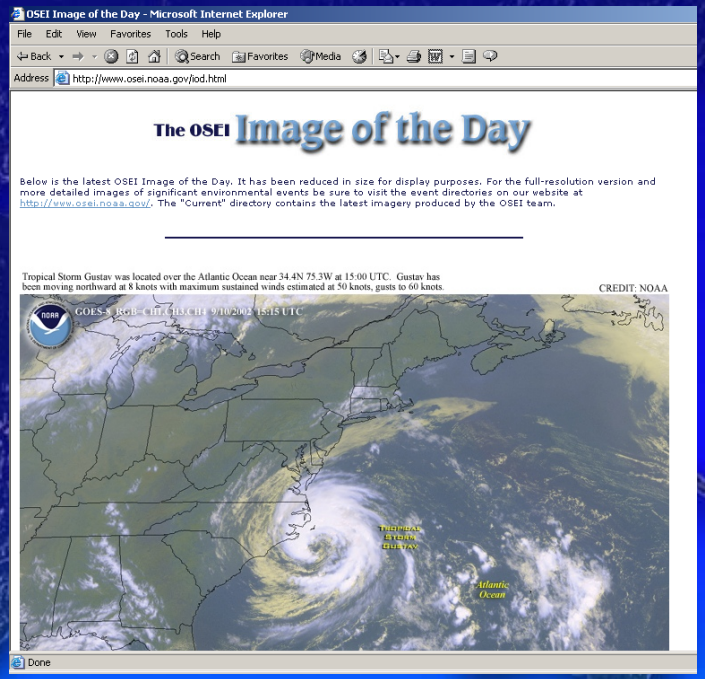


http://www.goes.noaa.gov/

SSD Service to the Public

High Resolution Imagery for Media

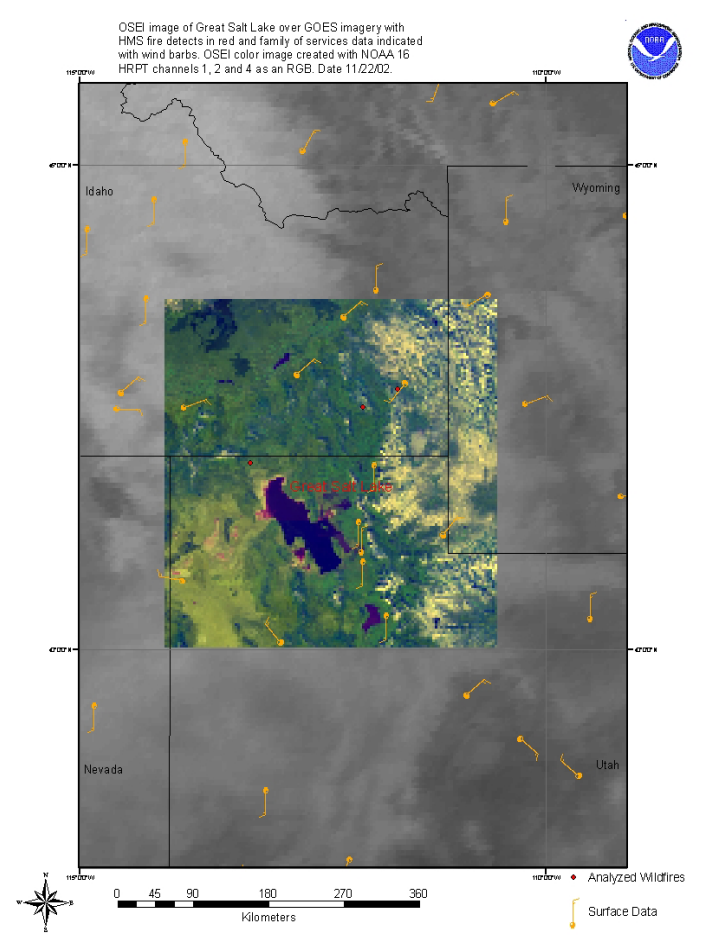




Operational Significant Events Imagery (OSEI)

http://www.osei.noaa.gov/

GIS Development



Objectives: Support NOAA's Enterprise-wide effort for a Geospatial one-stop website for data sharing:

- Ability to overlay numerous SSD products in a GeoTIFF format.
- Output compatible with any GIS platform.
- NOAA-16 HRPT RGB Geo-referenced GeoTIFF image produced with ENVI software.
- Hazard Mapping System (HMS) wildfire detection .
- Surface Wind direction and speed over GOES West image.

Websites of Interest

- Operational Significant Event Imagery Website (http://www.osei.noaa.gov)
- Satellite Services Division Website (http://www.ssd.noaa.gov)
- Joint Typhoon Warning Center Products (http://www.npmoc.navy.mil/jtwc.html)
- National Hurricane Center (http://www.nhc.noaa.gov/products.html)
- Volcanic Ash Advisory Centers (http://www.ssd.noaa.gov/VAAC/)
- Global Volcanism Program (http://www.volcano.si.edu/gvp/gvn/notices.htm)
- National Interagency Fire Center (http://www.nifc.gov)
- Global Fire Monitoring Center (GFMC) (http://www.ruf.uni-freiburg.de/fireglobe/)
- NASA Global Fire Monitoring (http://earthobservatory.nasa.gov/Library/GlobalFire/fire_5.html)
- International Geosynchronous Imagery (http://www.goes.noaa.gov)

Some of SSD's Customers

- NWS Forecast Offices, National Centers, and Riverforecast Centers
- National Marine Fisheries Service
- World Meteorological Organization (WMO)
- European Weather Center
- Bureau of Reclamation
- NASA
- Fleet Numerical Meteorology and Oceanography Center
- The Weather Channel
- National Snow and Ice Data Center
- Various Worldwide Universities
- Department of Defense (Air Force Weather Agency)
- National Weather Service (NWS)
- Federal Aviation Administration (FAA)
- Federal Emergency Management Agency (FEMA)
- US Airlines (United, Continental, American, Atlas)
- Federal Express
- 20 Meteorological Watch Offices in Mexico, Central America, northern South America, and Caribbean

Some of SSD's External Affiliations

- NESDIS Information Technology Architecture Team (ITAT)
- International Charter on Space and Major Disasters
- NESDIS Data Archiving Board
- Federal Aviation Administration Volcanic Ash Advisory Team
- NWS Integrated Aviation Work Team
- AWIPS Joint Engineering Team (JET)
- GOES-R Planning Team(s)
- NOAA Diversity Council
- NOAA Enterprise Geographic Information System (GIS) Working Group
- World Meteorological Organization (WMO) Commission for Aero Meteorology
- NESDIS Data User's Working Group
- NPP/NPOESS Planning Team(s)
- NOSF and NOSC Building Planning Teams